FINAL WORK PLAN

REMEDIAL INVESTIGATION OF THE FORMER BUILDING 6621 PESTICIDES SHOP AT FORT GEORGE G. MEADE, MARYLAND

Prepared for
Fort George G. Meade
ANME-PWE
Environmental Management Office
Fort Meade, Maryland 20755-5115

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AEC	Army Environmental Center
bgs	below ground surface
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act (Superfund)
CHPPM	U.S. Army Center for Health Promotion and Preventive Medicine
EMO	Fort Meade Environmental Management Office
EPA	Environmental Protection Agency
ERA	Ecologic risk assessment
FPS	Former Pesticides Shop
FSP	Field Sampling Plan
GPS	Global positioning system
HHRA	Human health risk assessment
HSP	Health and Safety Plan
IDW	Investigation-derived waste
IRP	Installation Restoration Program
MDE	Maryland Department of the Environment
PCB	polychlorinated biphenyl
POC	Point of contact
QAPP	Quality Assurance Project Plan
RBC	Risk Based Concentration
RI	Remedial Investigation
SHSP	Site-Specific Health and Safety Plan
SI	Site Investigation
SOPs	Standard Operating Procedures
TCLP	Toxicity Characteristic Leaching Procedure
URS	URS Group, Inc.
USACE	United State Army Corps of Engineers

This Remedial Investigation (RI) Work Plan presents the framework, protocols, project objectives, and approach to be used in performing an RI at the Former Building 6621 Pesticides Shop (Former Pesticides Shop [FPS]) at Fort George G. Meade (Fort Meade), Maryland.

1.1 PROJECT AUTHORIZATION

The Fort Meade Environmental Management Office (EMO) selected URS Group, Inc. (URS) to perform a Remedial Investigation (RI) of the Former Building 6621 Pesticides Shop at Fort Meade under Contract No. W912DR-04-D-0003, Delivery Order 0008. The work required will be conducted under the auspices of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and in accordance with applicable federal, state, and local guidance.

1.2 SCOPE AND OBJECTIVES

The scope of the remedial investigation is to:

- Review existing site monitoring data in order to determine sample collection locations.
- Prepare this Site-Specific Work Plan, which includes:
    - Field Sampling Plan (FSP), including reference to applicable Standard Operating Procedures (SOPs),
    - Quality Assurance Project Plan (QAPP), and
    - Site-Specific Health & Safety Plan (SHSP).
- Perform the RI field work, which includes collecting environmental samples of soil and groundwater, surveying the locations of sample points and other features, and proper handling and disposal of investigation-derived waste (IDW).
- Conduct laboratory analysis, data validation, and data management of the soil and groundwater samples collected.
- Prepare an RI Report to include a human health risk assessment (HHRA) and screening level terrestrial ecologic risk assessment (ERA).
- Attend meetings and manage this project.

The objective of the RI is to delineate the extent of potential contamination surrounding the Former Building 6621 Pesticides Shop at Fort Meade.

1.3 LOCATION AND GEOMORPHOLOGY

Fort Meade is located in Anne Arundel County, Maryland (Figure 1-1). The location of former Building 6621 at Fort Meade is illustrated in Figure 1-2. In general, the topography of Fort Meade is characterized by flat land that gently slopes towards infrequent water bodies throughout the base. Much of the base topography has been altered by development.

1.4 SITE GEOLOGY

Fort Meade is located in the Atlantic Coastal Plain physiographic province and is underlain by a thick wedge of unconsolidated sediments that dip and thicken to the southeast. The sediments beneath the installation are Early Cretaceous in age and belong to the Potomac Group (U.S. Army Corps of Engineers, 2003). The Potomac Group consists, from youngest to oldest, of the Patapsco, Arundel, and the Patuxent Formations, comprising a total thickness of more than 600 feet. These formations are characterized as fluvial and lacustrine deposits consisting of interbedded sand, silt, and clay that are limited in extent.

The Patapsco Formation can be subdivided into an upper, middle, and lower unit. The thickness of the upper Patapsco unit varies from 1 to 40 feet across the installation, and appears to pinch out to the west. This unit consists of mottled, medium-fine sand to silty sand, usually yellow-brown, yellow-orange, light brown, or gray in color. Rare intercalated thin beds of clay and gravel are also present.

The middle Patapsco unit consists of a thick, hard, highly plastic, mottled, red-brown to light-gray colored clay. This unit has an average thickness of 50 feet with a maximum recorded thickness of 102 feet. Very fine silty sand lenses, 2 to 16 feet in thickness, are present throughout the middle unit. An intercalated black coal seam is present near the base of the unit.

The lower Patapsco unit consists of medium fine silty sand that grades downward into coarse sand with minor silt. The color of this unit varies from pale to dark yellow-orange, dark brown, and dark yellow. The transition between the middle and lower units is gradual, marked by alternating silty sands and silty clays. The regional thickness of this unit ranges from 80 to 100 feet.

The Arundel Formation is approximately 250 feet thick. This formation consists of massive beds of red, brown, and gray clay with several more permeable layers present. The Patuxent Formation underlies the Arundel Formation and overlies Precambrian to early Cambrian igneous and metamorphic rocks. The Patuxent Formation is composed primarily of sand and gravel with minor amounts of silty clay and clay.

1.5 SITE HYDROGEOLOGY

Three distinct aquifers are present in the unconsolidated sediments beneath the site. The aquifers are known locally as the upper and lower Patapsco and the Patuxent aquifers. Two confining layers, an unnamed unit corresponding to the middle Patapsco unit (herein referred to as the middle Patapsco confining unit) and the Arundel Formation, separate the three aquifers. The lower Patapsco and Patuxent aquifers are under confining conditions except where the aquifers outcrop and water table conditions prevail.

The upper Patapsco aquifer is an unconfined/water table aquifer. The regional groundwater flow is to the southeast; however, due to influences in topography, the local groundwater flow direction is highly variable. The hydraulic conductivity of the upper Patapsco aquifer ranges from 3×10^{-5} to 6×10^{-3} centimeters per second (cm/sec) (U.S. Army Corps of Engineers, 2003).

The lower Patapsco aquifer acts as both a water table and as a confined aquifer depending upon the presence of the upper and middle Patapsco units. The regional groundwater flow in the lower Patapsco aquifer is to the southeast; though the local groundwater flow direction also varies. The

hydraulic conductivity of the lower Patapsco aquifer ranges from 4×10^{-4} to 2×10^{-3} cm/sec for the confined portions of the aquifer and from 1×10^{-4} to 2×10^{-2} cm/sec in the unconfined portions of the aquifer (U.S. Army Corps of Engineers, 2003).

The Patuxent aquifer is the deepest aquifer present in the unconsolidated material and is under confined conditions beneath the installation. The regional groundwater flow direction is to the southeast, consistent with the regional dip.

As stated above, the two confining units separating the three aquifers are the middle Patapsco unit and the Arundel Formation. The vertical hydraulic conductivity of the middle Patapsco unit has been documented at 1×10^{-8} to 2×10^{-7} cm/sec (U.S. Army Corps of Engineers, 2003).

1.6 SITE HISTORY AND PREVIOUS INVESTIGATIONS

Fort Meade was listed on the National Priorities List in 1998. The Fort Meade EMO, located at Fort Meade, Maryland, has responsibility for managing the restoration efforts at all known and suspected areas where CERCLA releases have or may have occurred. Previous environmental investigations and sampling has been conducted at the Building 6621 site. All investigations were conducted after the building was demolished in 1996 and the site regraded.

Site Investigation (SI) data exist for the site, as summarized in three reports; NuTec Design Associates, Inc. and Dewberry & Davis, 1997 (NuTec, 1997), Versar, Inc., 2003 (Versar, 2003), and Versar, Inc., 2004 (Versar, 2004). A review of these data has been conducted to determine the placement of samples to be collected as part of this RI. Preliminary data review findings are summarized in the following three subsections.

1.6.1 1997 Comprehensive Site Assessment and Relative Risk Site Evaluation for Building 6621

NuTec (1997) reported that Building 6621 was located at the southwest corner of York Avenue and Gordon Street, approximately 700 feet east of Mapes Road on Fort Meade. The building was reportedly built before WWII on an 18-24" concrete slab without footings and had terra cotta walls. The building was reportedly labeled "Mess Hall" in the Real Property records and had been used during WWII as a mess hall for prisoners of war. The site was reportedly used as a Pesticides Shop for 20 years between 1958 and 1978. During this time it was also used as a maintenance facility for lawn mowers, tractors, and other landscaping equipment. Building 6621 was reportedly demolished and the site regraded in 1996.

The pesticide shop and pesticide storage and mixing operations were reportedly limited to the central portion of the U-shaped building, as shown in Figure 1-2. All mixing and transfer reportedly occurred in this courtyard of Building 6621 (Figure 1-2).

Some of the chemicals reportedly kept at Building 6621 in the past include the pesticides DDD, DDT, Malathion (CAS No. 121-75-5), Diazinon (CAS No. 333-41-5), Baygon (CAS No. 114-26-1), Chlordane, and several brands of rodenticides. Most of the listed chemical compounds are on the U.S. Environmental Protection Agency (EPA) Region 3's Risk-Based Concentration (RBC) table. Malathion, Diazinon, and Baygon were not analyzed by this study (NuTec, 1997) or the other two later studies (Versar, 2003 and Versar, 2004). Several pesticides, along with some metals, have been detected in site soils, as will be shown in this section. Eight samples

were collected by NuTec from four locations on February 26, 1997 and analyzed for pesticides and metals. Table 1-1 summarizes the chemical compounds detected during this sampling event.

Table 1-1: Summary of Chemical Concentrations (mg/kg) from February 1997 Sampling

Sample location	Depth of Sample Collection	4,4-DDD	4,4-DDT	Chlordane	Mercury
S-1A	6"-12"	260	50	160	<0.05
S-1B	12"-18"	<32	110	450	0.08
S-2A	6"-12"	14	66	110	Not detected
S-2B	12"-18"	31	130	180	0.07
EPA RBC – Residential soil		2.7	1.9	1.8	7.8
EPA RBC – Industrial soil		12	8.4	8.2	100
EPA RBC – Soil for Groundwater Protection DAF20		11	1.2	0.92	--

Soil samples S-1 and S-2 were collected within the U-shaped inner courtyard of where former building 6621 was located (Figure 1-3). No medium other than soil was analyzed. Samples S-3 and S-4, collected east of the footprint of the former building, reported no detections of the compounds analyzed for. The detection limits for all of the metals, except mercury, were very high (0.5% or 5,000 mg/kg), rendering none of the metals results particularly useful. The following exceedances of risk-based standards were noted:

Table 1-2: Exceedances of Risk-Based Standards from February 1997 Sampling

Chemical	Maximum Detection (mg/kg)	Number of Times Standard Exceeded		
		EPA Residential RBC	EPA Industrial RBC	EPA SSL (DAF20)
4,4-DDD	260	3	3	3
4,4-DDT	130	4	4	4
chlordane	450	4	4	4
mercury	0.08	0	0	NA

NA: Comparison value not available.

Based on the soil sampling and analysis results, the following chemicals were inferred to be site contaminants: 4,4-DDD; 4,4-DDT, chlordane, and mercury. URS notes that mercury is not a site contaminant of concern because site concentrations do not exceed the EPA Region 3 risk-based concentrations.

Neither the horizontal or vertical extent of these chemicals were determined in soil, the deepest samples having been collected from 12 to 18 inches below ground surface (bgs) and no samples collected north, south, or west of the positive detections.

1.6.2 2003 Soil Investigation at Former Building 6621

Versar collected four soil samples at three locations in September 2003 and analyzed the samples for pesticides, polychlorinated biphenyls (PCBs) and metals. Table 1-3 summarizes the chemical compounds detected during the September 3, 2003 sampling event.

Table 1-3: Summary of Chemical Concentrations (mg/kg) from September 2003 Sampling

Sample location	Depth of Sample Collection	**Chlordane**	**Arsenic**	**Chromium**	**Iron**
B6621-SB1	0"-6"	84.6	39.4	9.5	7,120
B6621-SB1	6"-12"	198	Not detected	Not detected	Not detected
B6621-SB2	0"-6"	<0.018	10.5	35.5	11,400
B6621-SB3	0"-6"	0.534	1.4	8.2	6,270
EPA RBC – Residential soil		1.8	0.43	230 [1]	23,000
EPA RBC – Industrial soil		8.2	1.9	3,100 [1]	310,000
EPA RBC – Soil for Groundwater Protection DAF20		0.92	0.026	42 [1]	--

[1]Chromium VI assumed

Soil sample B6621-SB1 was collected at the location of the former pesticide mixing area, within the U-shaped inner courtyard of former building 6621 (Figure 1-3). Samples B6621-SB2 and B6621-SB3 were collected north and east, respectively, of the footprint of the former building. The following exceedances of risk-based standards were noted:

Table 1-4: Exceedances of Risk-Based Standards from September 2003 Sampling

Chemical	**Maximum Detection (mg/kg)**	**Number of Times Standard Exceeded**		
		EPA Residential RBC	**EPA Industrial RBC**	**EPA SSL (DAF20)**
chlordane	198	2	2	2
arsenic	39.4	3	2	3
chromium	35.5	0	0	0
iron	11,400	0	0	NA

[1]Chromium VI assumed

Chlordane and arsenic were concluded to be site contaminants; however, URS notes that chromium was also detected at a concentration greater than the regulatory standards presented in the Versar report and used to identify site contaminants.

Neither the horizontal or vertical extent of these chemicals were determined in soil, the deepest samples having been collected from 6 to 12 inches bgs and samples were not collected southeast nor southwest of the detections in sample B6621-SB1.

1.6.3 2004 Soil Investigation at Former Building 6621

Versar collected 24 soil samples from ten locations in January 2004 and analyzed the samples for pesticides, herbicides, arsenic, and mercury. The pesticides delta-BHC, chlordane, alpha-chlordane, gamma-chlordane, dieldrin, 4,4'-DDD, 4,4'-DDE, 4,4'-DDT, heptachlor, and heptachlor epoxide along with the herbicides 2,4-D, 2,4,5-T and pentachlorophenol were detected in site soil. Table 1-5 summarizes the highest concentration of select chemical compounds detected during the January 27, 2004 sampling event.

Table 1-5: Summary of Chemical Concentrations (mg/kg) from January 2004 Sampling

Sample location	Depth of Sample Collection	**Chlordane**	**alpha-Chlordane**	**gamma-Chlordane**	**4,4-DDD**	**4,4-DDT**	**Heptachlor**	**Arsenic**
B6621-SB01	0-0.5'	84.6	Not detected	Not detected	Not detected	3.5	Not detected	39.4
B6621-SB01	1-2.5'	9.34	1.76	1.42	0.716	0.627	0.155	**55.7**
B6621-SB05	0-1'	156	29.1	23.1	15.9	27.5	3.5	14.6
B6621-SB06	0-1'	**482**	**91.1**	**80.7**	**67.6**	39.2	**5.67**	38.4
B6621-SB06	1-2.5'	9.47	1.55	1.32	8.53	28.5	Not detected	4.0
B6621-SB07	1-2.5'	87	Not detected	Not detected	19.5	**103**	Not detected	2.9
B6621-SB07	2.5-4'	Not detected	Not detected	Not detected	11.8	83	Not detected	1.3
EPA RBC – Residential soil		1.8	--	--	2.7	1.9	0.14	0.43
EPA RBC – Industrial soil		8.2	--	--	12	8.4	0.64	1.9
EPA RBC – Soil for Groundwater Protection DAF20		0.92	--	--	11	1.2	0.84	0.026

Bold = The highest concentrations

The highest concentrations of compounds detected were near the former mixing pad, within the U-shaped inner courtyard of former building 6621 (Figure 1-3). The following exceedances of risk-based standards were noted based on all of the data:

Table 1-6: Exceedances of Risk-Based Standards from January 2004 Sampling

Chemical	Maximum Detection (mg/kg)	Number of Locations Where Standard Exceeded		
		EPA Industrial RBC	EPA Residential RBC	EPA BTAG Fauna
chlordane	482	5	6	9
alpha-chlordane (a)	91.1	3	4	0
gamma-chlordane (a)	80.7	2	4	0
4,4'-DDD	67.6	4	4	8
4,4'-DDT	103	3	4	9
heptachlor	5.67	3	5	0
arsenic	55.7	10	10	0
dieldrin	0.12	0	1	1
4,4'-DDE	4.34	0	2	6
mercury	0.85	0	0	8
2,4-D	1.09	0	0	1

(a) Assumes chlordane RBCs.

URS also notes that the single detection of 2,4-D (1.09 mg/kg) in one of the four site soil samples is well below the residential RBC for this chemical (780 mg/kg), indicating that 2,4-D is not a relevant site contaminant. 2,4-D was the only herbicide detected above any of the criteria, indicating that herbicides detectable by the method used (SW846 method 8151) are not chemicals of concern.

A general URS soil observation at this stage in the data review is that the horizontal and vertical limits of soil exceedances of EPA RBCs cannot be defined by the existing data sets. In other words, the limits of the soil contamination are not bounded. The numerous EPA RBC exceedances beyond the immediate vicinity of where the pesticides were reported to have been stored and handled suggests that site grading activities may have spread contamination at the site. The lack of horizontal and vertical delineation is revealed by Figure 1-3. It is a compilation of the sampling from these three reports which presents the historic soil sampling locations. Most of the samples presented on Figure 1-3 had detections of chemical compounds above one or more of the criteria.

This section of the Work Plan details the soil and groundwater sampling approach to perform the RI. The purpose of the sampling will be to evaluate and delineate potential contamination at the site. Since the spread of site soil is not known, samples will be collected in a grid pattern designed to cover beyond the extent of the area investigated previously. Samples will be collected at multiple depths beyond the depths sampled previously. Groundwater samples will be collected to determine if site activities affected this medium. Since no surface water bodies are proximal to the site, surface water and sediment samples will not be collected.

To accomplish the task objectives, URS will perform the activities listed in this section. It is proposed that the Field Geologist (field team leader) be empowered with field decision capabilities to evaluate what samples should be analyzed, based on field observations of the materials encountered and consultation with the Fort Meade representative.

The methodologies for sample collection and documentation are presented in the SOPs in Appendix A.

2.1 PRELIMINARY FIELD ACTIVITIES

URS will obtain a digging permit from Fort Meade prior to advancing any borings at the site. URS will hire an independent subsurface testing company to verify the locations of any on-site utilities at each subsurface sampling location at the site. Before initiating field efforts involving borings, URS will subcontract an outside contractor to clear the proposed sampling locations for utilities. URS will coordinate with Fort Meade to schedule the work and provide a minimum of 48 hours notice, via telephone, to the points of contact at Fort Meade prior to beginning field work on the project. Points of contact names and telephone numbers are listed in Section 3 of this Work Plan.

2.2 PERSONNEL PROTECTION REQUIREMENTS

Fort Meade has a base-wide generic Health and Safety Plan (HSP) that was developed for overall health and safety measures to be implemented for activities that occur under the Installation Restoration Program (IRP) (i.e., CERCLA work). URS has also prepared a SHSP (included in Appendix C) for the implementation of work conducted for this RI. Each individual who works on this project will read and sign the SHSP attesting knowledge and understanding of the health and safety aspects of the project.

2.3 REMEDIAL INVESTIGATION FIELD WORK

After approval of the project work plan and obtaining the excavation permit, site investigation environmental samples will be collected. Sampling will be limited to soil and groundwater because there are no receiving water bodies proximate to the site (the stormwater retention pond located at the north end of the site does not currently receive surface runoff from the area of the Former Pesticides Shop).

2.3.1 Soil Sampling for Horizontal Chemical Extent

A total of 25 surface soil grid samples will be collected to delineate the horizontal extent of soil contamination at the site (Figure 2-1). An additional 10 “feature-specific” surface soil samples

will be collected from areas exhibiting characteristics suggestive of possible contamination (Figure 2-1).

2.3.2 Soil Sampling for Vertical Chemical Extent

The vertical extent of site-related compounds will be investigated with sets of soil samples collected with direct push technology from surface soil samples to depths up to 24 feet below ground surface (bgs). The extent of vertical contamination is expected to be greatest near the source area and lesser at areas beyond the source where contamination may have been spread during site surface grading activities.

At three locations within the source area, soil samples for chemical analysis will be collected from the following depth intervals in feet bgs: 2-4, 4-6, 6-8, 8-10, 14-15, 19-20, and 23-24 (total of 21 direct push soil samples).

Beyond the source area, shallow to intermediate depth soil samples will be collected, coincident with 10 of the grid sample locations and 5 of the "feature-specific" sample locations previously discussed. At each of these 15 locations, the surface grab samples will be supplemented with intermediate depth samples to be collected using the direct push sampling technique from the following depth intervals in feet bgs: 2-4, 4-6, and 6-8 (total of 45 direct push soil samples). The total number of proposed soil samples is shown in Table 2-1.

Table 2-1: Number of Proposed Soil Samples

Sample Category	Number of Samples / (Locations)
Horizontal (surface); Grid Samples	25 (25)
Horizontal (surface); Feature Samples	10 (10)
Total surface samples	*35*
Vertical (subsurface); Source Area	21 (3)
Vertical (subsurface); Beyond Source Area	45 (15)
Total subsurface samples	*66*
Total Environmental Samples:	**101**
Quality Control Samples	5
Total:	**106**

2.3.3 Soil Sample Chemical Analysis

All soil samples will be analyzed for arsenic and chromium (SW846 6010B), organochlorine pesticides (SW846 8081A), and organophosphorus pesticides (SW846 8141A). Of the pesticides NuTec (1997) reported were stored in Building 6621 in the past, Baygon is the only pesticide not being analyzed for. Baygon is only analyzed by EPA method SW846 8318, which is not readily practiced by most laboratories. Because of the difficulties in obtaining a laboratory that can analyze for SW846 8318, this method is not included in the list of analysis for soil or groundwater sampling.

2.3.4 Groundwater Sampling and Analysis

Based on regional topography and drainage, a southward to southeastward groundwater flow direction is currently estimated. Four temporary direct push monitoring wells will be installed to facilitate groundwater sampling and determine groundwater flow direction. Well MW-1 will serve as an up-gradient well, to be located near the extreme northwestern corner of the site. Well MW-2 will be located centrally at the former pesticides storage/mixing area, representing the location where groundwater would most likely be impacted. Well MW-3 will be a down-gradient well located near the storm drain adjacent to York Avenue. Well MW-4 will be a down-gradient well located south-southeast of the former pesticides storage/mixing area, adjacent to Gordon Street. Each well will be 2-inch-diameter PVC constructed with a 10-foot-long screen that straddles the water table.

All groundwater samples will be analyzed for arsenic and chromium (SW846 6010B), organochlorine pesticides (SW846 8081A), and organophosphorus pesticides (SW846 8141A). The total number of proposed groundwater samples is shown in Table 2-2.

Table 2-2: Number of Proposed Groundwater Samples

Sample Category	Number of Samples
Temporary direct push monitoring wells	4
Quality Control Samples	1
Total:	**5**

2.3.5 Surveying

All planned soil sample collection locations will be staked in the field prior to sample collection, based on sample-specific coordinate data to be determined in URS' office. Staking will be facilitated by a combination of a Global Positioning System (GPS) and measuring tape from known reference points. Other features to be staked include the following identified in Figure 3 of the 1997 NuTec/Dewberry & Davis report:

- Former Pesticide Storage Area
- Former Pesticide Shop Area
- Former Pesticide Mixing / Handling Area

A professional surveyor will be used to survey the horizontal locations and vertical elevations of the wells.

2.3.6 Investigation-Derived Waste

Investigation-derived waste (IDW) includes all potentially contaminated waste materials generated during the sampling program. URS will containerize and temporarily stage IDW onsite at Fort Meade. IDW will be sampled by URS and, per Dave Kandt at Fort Meade, once URS provides Fort Meade the toxicity characteristic leaching procedure (TCLP) results the installation will be responsible for IDW disposal.

2.4 LABORATORY ANALYSIS, DATA VALIDATION, AND DATA MANAGEMENT

All samples will be analyzed by Severn Trent's North Canton, Ohio laboratory (STL). URS will ship samples to STL daily during the field activities. Hard copy and electronic data deliverables will be provided to URS by STL within 28 days of sample receipt by the laboratory. Also to be provided to URS will be data packages sufficient to support URS' Level 4 data validation in accord with EPA's National Functional Guidelines. The data will be managed in URS' data management system.

2.5 REMEDIAL INVESTIGATION REPORTING

Reporting involves preparation of Draft, Draft Final, and Final versions of the RI Report, to include a HHRA and a screening level terrestrial ERA. The report will describe the nature and extent of contamination, assess the potential current and future human health and ecologic risks posed by the contamination, and offer site management recommendations based on the findings of these assessments per guidance for development of a remedial investigation report under CERCLA.

The RI report shall be prepared in Draft, Draft Final, and Final versions for submittal to the U.S. Army (Fort Meade, U.S. Army Center for Health Promotion and Preventive Medicine [CHPPM], and Army Environmental Center [AEC]) and regulatory agencies for review and comment. URS will prepare written responses to all comments on the Draft and Draft Final Reports. Comments will be incorporated into the Draft Final, and Final Reports as appropriate. The Final RI Report will be provided in hard copy and electronic format per the submittal list identified at the end of this Work Plan.

The project will be managed by URS under the direction of Project Manager Bill Eaton. Key points of contact (POCs) for project execution and their roles on the project are listed in Table 3-1.

Table 3-1: Project Organization and Contacts

Project Position and Role	Contact Name and Address	Notification Requirements Prior to Fieldwork
Fort Meade Contracting Officer Representative	Ms. Carroll P. Hicks 4551 Llewellyn Avenue Fort George G Meade, Maryland 20755-5000 Office Phone: 410-962-4880	URS to notify of any proposed changes in scope of work
Contracting/Ordering Officer	Ms. Mary Richie 10 S. Howard Street Baltimore, Maryland 21203 Office Phone: 410-962-4880	URS to coordinate project schedule with POCs
Fort Meade Project Manager	Ms. Kimberly Gross Fort George G. Meade Attn: DPW-EMO Environmental Management Office 239 Ross Street Fort Meade, Maryland 20755-5115 Office Phone: 301-677-9365	URS to provide a minimum of 48 hours notification prior to beginning fieldwork
URS Project Manager • Primary POC for USACE, subcontractors, and site personnel • Provides day-to-day direction of project activities	Mr. Bill Eaton URS Group, Inc. 200 Orchard Ridge Drive, Suite 101 Gaithersburg, Maryland 20878 Office Phone: 301-258-9780 Fax: 301-869-8728 Direct: 301-258-5804	
URS Program Manager • Available to assist with issue resolution • Technical oversight	Scott McClelland, PG URS Group, Inc. 200 Orchard Ridge Drive, Suite 101 Gaithersburg, Maryland 20878 Office Phone: 301-258-9780 Fax: 301-869-8728 Direct: 301-258-5876	
URS Health, Safety and Environment Representative • Reviewed and approved HSP • Available to assist with any health and safety issues or concerns during project execution	Patsy Glinsmann, Certified Industrial Hygienist URS Group, Inc. 200 Orchard Ridge Drive Gaithersburg, Maryland 20878 Office Phone: 301-258-9780 Cell Phone: 202-210-5056 Home Phone: 202-484-0933 Fax: 301-869-8728	
Public Works Director • Project Review / Approval	Directorate of Public Works Attn: ANME_PWE (Mick Butler) Building 239 2 ½ Street and Ross Road Fort Meade, Maryland 20755	

Project Position and Role	Contact Name and Address	Notification Requirements Prior to Fieldwork
EPA Project Manager • Regulatory Review / Approval	EPA Bob Stroud US EPA Environmental Center 701 Mapes Road Fort Meade, Maryland 20755	
MDE Project Manager • Regulatory Review / Approval	MDE Dave Healy Maryland Department of the Environment Hazardous Waste Program 1800 Washington Boulevard Baltimore, MD 21230-1719	
AEC Project Manager • Army Review / Approval	AEC Doug Scarborough USAEC ATTN: SFIM-AEC-ERA APG, MD 21010-5401	
Health Assessment Review / Approval	CHPPM Point of Contact to be Determined *Environmental Health Risk Assessment Program* U.S. Army Center for Health Promotion and Preventive Medicine ATTN: MCHB-TS-REH, Bldg. E1675 APG-EA, MD 21010	
Utility markout	TBD	URS to notify prior to planned excavation
Direct Push driller	TBD	
Laboratory	TBD	
Surveyor	TBD	

All final documents will be submitted on a CD-ROM (PDF format for all and source files for Ft. Meade) as well as a hard copy. All draft documents will also be submitted electronically in order to satisfy the request of regulators. The following documents will be submitted for review:

Table 3-2: Documents to be Submitted for Review

Submittal	Copies to Review Agencies (a)				
	DPW	EPA	MDE	AEC	CHPPM
Internal Draft Work Plan	1	--	--	--	--
Draft Work Plan	2	3	1	1	--
Final Work Plan	2	3	1	1	--
Internal Draft RI Report	1	--	--	--	--
Draft RI Report	2	3	1	1	1
Final RI Report	2	3	1	1	1
Meeting Minutes	ea	ea	ea	ea	ea
Progress Reports	monthly	--	--	--	--

The estimated project schedule for this RI is presented in Table 4-1.

Table 4-1: Estimated Schedule (a)

Item	Start Date	Duration (weeks)	End Date
Notice to proceed	5/2/2005	0	5/2/2005
Obtain and review existing documents	4/18/2005	6	5/30/2005
Submit Internal Draft Work Plan	5/2/2005	4	5/27/2005
Comments on Internal Draft Work Plan	5/28/2005	3	6/23/2005
Submit Draft Final Work Plan	6/24/2005	2	7/12/2005
Comments on Draft Final Work Plan	7/13/2005	15	10/26/2005
Submit Final Work Plan	10/27/2005	11	1/10/2006
Clear locations of subsurface utilities and Obtain Excavation Permit	1/11/2006	6	2/26/2006
Mobilize for field investigation	2/27/2006	0	2/27/2006
Field work	2/27/2006	1	3/3/2006
Sample analysis	3/4/2006	4	3/31/2006
Data validation	4/1/2006	3	4/21/2006
Submit Draft Remedial Investigation Report	4/22/2006	6	6/2/2006
Comments on Draft Remedial Investigation Report	6/3/2006	6	7/14/2006
Submit Draft Final Report	7/15/2006	2	7/29/2006
Comments on Draft Final Report	7/30/2006	4	8/26/2006
Submit Final Report	8/27/2006	2	9/9/2006

(a) Shaded cells are actuals.

This schedule corresponds to a period of performance of 12 months. The schedule for the field work may be affected by wet weather and regulatory review cycles.

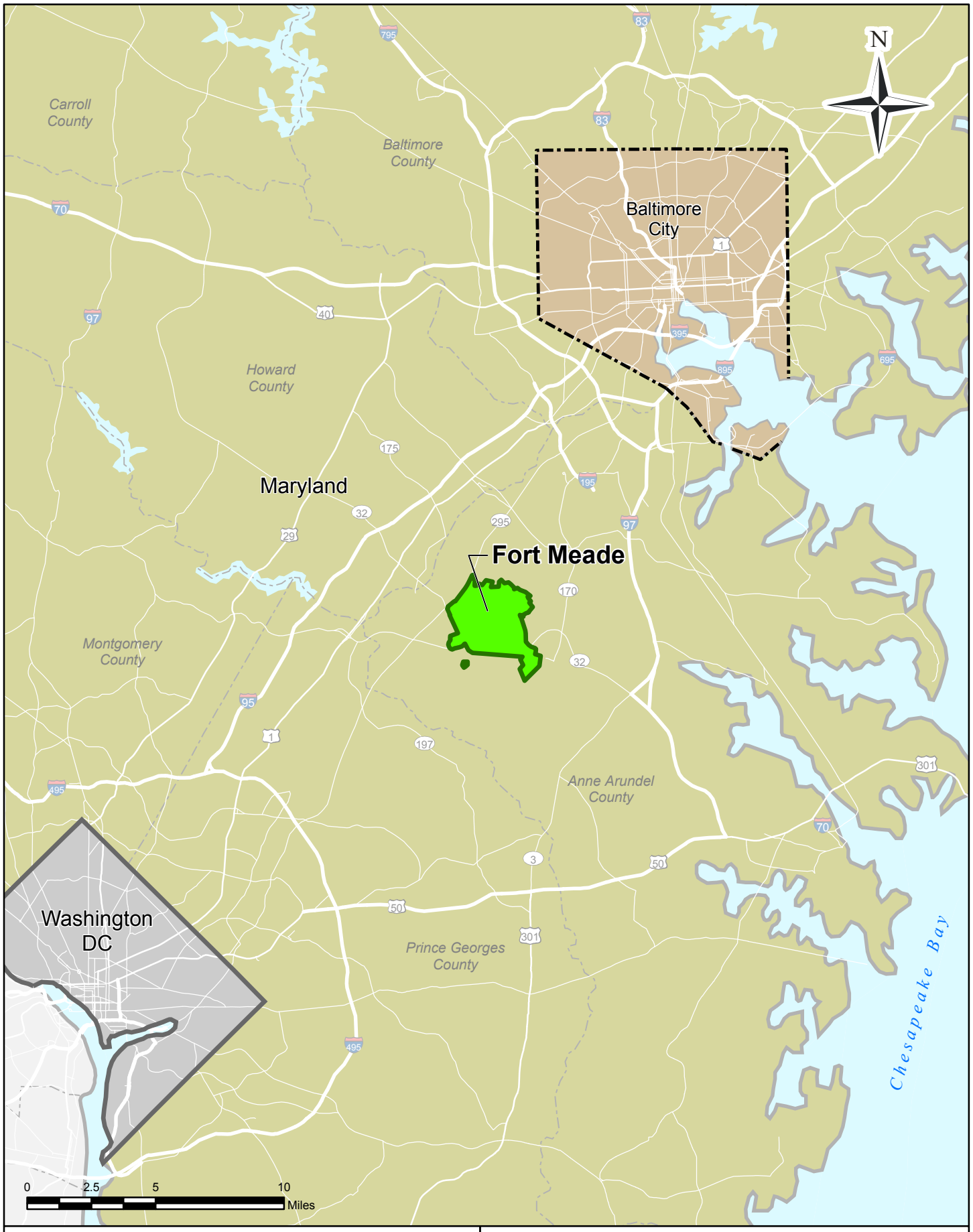
NuTec Design Associates, Inc. and Dewberry & Davis, 1997, *Comprehensive Site Assessment and Relative Risk Site Evaluation for the Military District of Washington's Defense Environmental Restoration Program, DSERTS Site No. FGGM13, Fort George G. Meade Pesticide Shop (Building 6621),* Final, May 28, 1997.

U.S. Army Corps of Engineers, 2003. *Fort George G. Meade Generic Field Sampling Plan*. Final Document. March 2003.

Versar, Inc., 2003, *Soil Investigation at Former Building 6621, Gordon Street and York Avenue, Ft. Meade, Maryland*, Versar Project No. 110941.00001.001, October 31, 2003.

Versar, Inc., 2004, *Soil Investigation at Former Building 6621, Gordon Street and York Avenue, Ft. Meade, Maryland*, Versar Project No. 110941.00001.002, April 19, 2004.

Figures

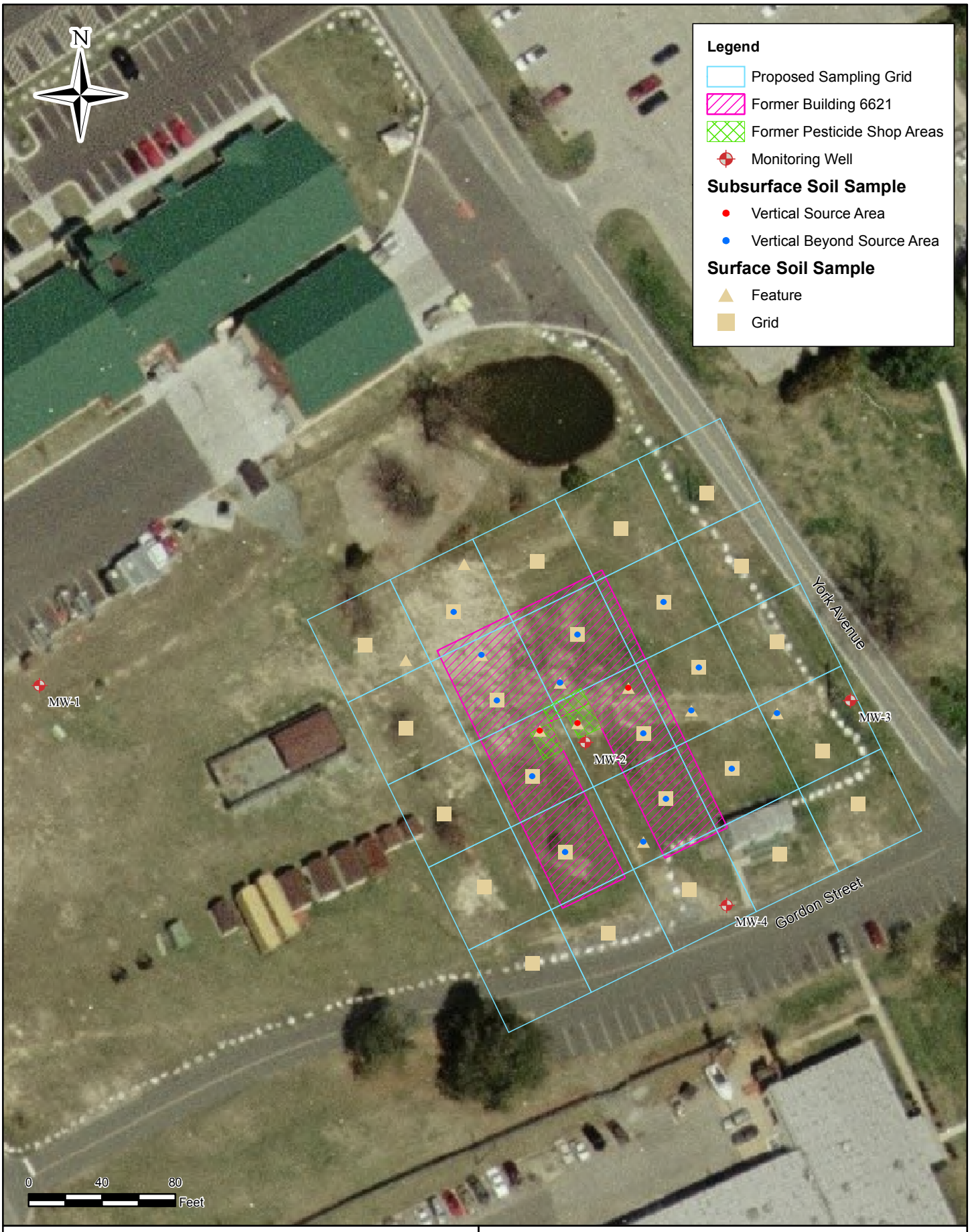


CLIENT	FORT MEADE	TITLE	Fort Meade Location Map		
PROJ	EUL EBS				
REVISION NO	1	DES BY	JMW	04/05/05	PROJ NO 15296957
SCALE	1" = 5 miles	DR BY	JMW	04/05/05	FIGURE 1-1
G:\FTMeade\Projects\ Figure1-1 Location.mxd		CHK BY	GPK	04/26/05	

URS
200 Orchard Ridge Drive
Gaithersburg, MD 20878

CLIENT	FORT MEADE			TITLE	Location of Former Building 6621 at Fort Meade
PROJ	Pesticide Building 6621				
REVISION NO	1	DES BY	JMW	05/09/05	URS 200 Orchard Ridge Drive Gaithersburg, MD 20878
SCALE	1" = 200'	DR BY	JMW	05/09/05	PROJ NO 15297463
G:\FTMeade\Projects\Bld6621.mxd		CHK BY	GPK	05/26/05	FIGURE 1-2

CLIENT	FORT MEADE			TITLE	Historic Sampling Locations
PROJ	Pesticide Building 6621				
REVISION NO	1	DES BY	JMW	05/23/05	URS 200 Orchard Ridge Drive Gaithersburg, MD 20878
SCALE	1" = 50'	DR BY	JMW	05/23/05	PROJ NO 15297463
G:\FTMeade\Projects\Bld6621histsamps.mxd		CHK BY	GPK	07/07/05	FIGURE 1-3



CLIENT	FORT MEADE			TITLE	Sampling Locations
PROJ	Pesticide Building 6621				
REVISION NO	2	DES BY	VAL	11/29/05	URS 200 Orchard Ridge Drive Gaithersburg, MD 20878
SCALE	1" = 80'	DR BY	JMW	05/10/05	PROJ NO 15297463
G:\FTMeade\Projects\Bld6621grid.mxd		CHK BY	GPK	05/26/05	FIGURE 2-1

Appendix B:

Quality Assurance Project Plan

Final
Quality Assurance Project Plan
Remedial Investigation at Former Pesticide Shop, Building 6621 (FGGM 13)
Fort George G. Meade, Maryland

Prepared for:

Fort George G Meade
2234 Huber Road
Fort Meade, Maryland 20755

Prepared by:

URS Group, Inc.
849 International Drive, Suite 320
Linthicum, Maryland 21090

Contract Number: W912DR-04-D-0003
Delivery Order No.: 0008
Date Issued: January, 2006

Commitment to Implement the above Quality Assurance Project Plan

Name: Mr. Bill Eaton
Title: Project Manager, URS Corporation
Address: 200 Orchard Ridge Drive, Gaithersburg, MD 20878
Phone: 301-258-5804

Signature: Bill Eaton Date: 1-10-06

Name: Mr. Jerry Kashatus
Title: Field Manager, URS Corporation
Address: 200 Orchard Ridge Drive, Gaithersburg, MD 20878
Phone: 301.258.9780

Signature: Date: 1-10-06

Name: Dr. Rosa Gwinn, PhD
Title: Quality Assurance Officer, URS Corporation
Address: 200 Orchard Ridge Drive, Gaithersburg, MD 20878
Phone: 301-258-5817

Signature: Date: 10JAN06

Name: Ms. Dorothy Leeson
Title: QA Manager, Severn Trent Laboratories (STL) – North Canton
Address: 4101 Shuffel Drive, NW, North Canton, Ohio 44720
Phone: 330-497-9396

Signature: Dorothy J. Leeson Date: 1/10/06

QUALITY ASSURANCE PROJECT PLAN

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STL Standard Operating Procedures ..... Attachment C

1.0 PROJECT ORGANIZATION AND RESPONSIBILITIES

The project organization and the responsibilities of key personnel are defined below with additional details in Section 2 of the FSP. Figure 1-1 presents the program lines of authority and generic project organization. Additional information with regards to the primary laboratory's organizational structure is provided in Appendix C. If required, the Quality Assurance (QA) laboratory will be chosen and contracted by U.S. Army Corps of Engineers (USACE).

1.1 RESPONSIBILITIES

1.1.1 USACE Project Manager

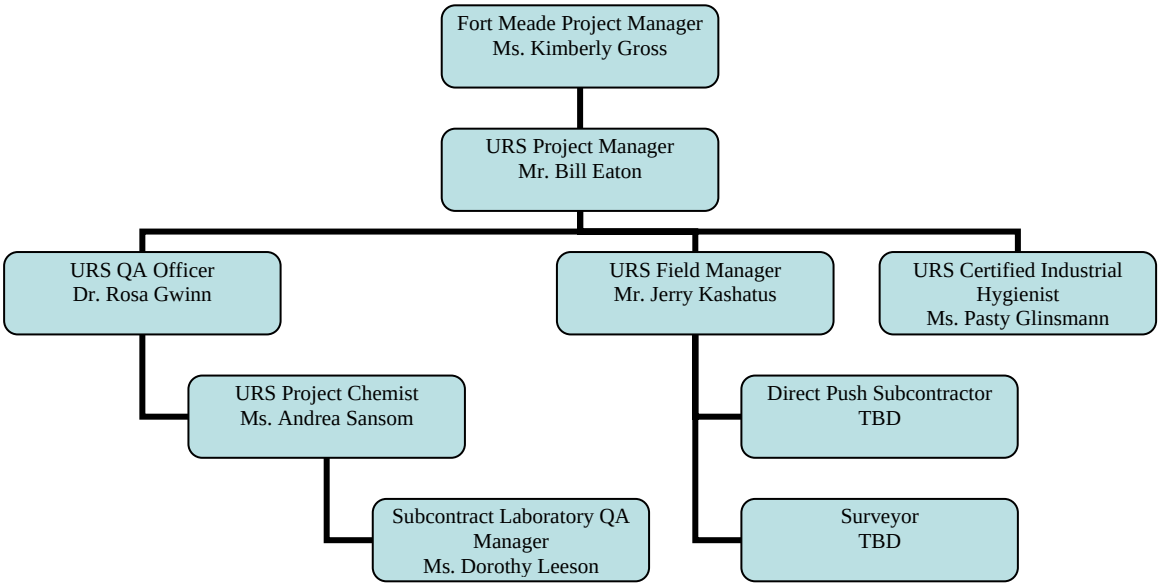
The Fort George G. Meade Project Manager, Ms. Kimberly Gross, is responsible for establishing project scope and objectives and for communicating same to URS Operating Services, Inc. (URS). She is also responsible for identifying internal, regulatory, and procedural requirements pertinent to the work that may differ from accepted industry standards of work.

1.1.2 URS Project Manager

The URS Project Manager, Mr. Bill Eaton, is responsible for assuring that the project is properly staffed and is ultimately responsible for the technical direction and quality of the work performed by URS personnel. He is responsible for establishing appropriate budgets and schedules, making available appropriate forms of training, and monitoring the performance of the staff. The Project Manager may talk with regulatory agencies regarding methodologies and requirements. He is also responsible for monitoring the implementation of the quality assurance program. Specific responsibilities include:

- Assure the provision of necessary facilities, equipment, and funding;
- Review and approve field procedures and other Project Controlling Documents (PCDs) (i.e., Quality Assurance Project Plan (QAPP) and Field Sampling Plan (FSP));
- Support the efforts of the Field Manager, QA Officer (QAO), and Laboratory Manager(s) in all matters concerning the quality of work products; and,
- Assure effective response to corrective action requirements identified by any member of the project team.

FIGURE 1-1


Fort Meade Project Manager
Ms. Kimberly Gross
URS Project Manager
Mr. Bill Eaton
URS QA Officer
Dr. Rosa Gwinn
URS Field Manager
Mr. Jerry Kashatus
URS Certified Industrial Hygienist
Ms. Pasty Glinsmann
URS Project Chemist
Ms. Andrea Sansom
Direct Push Subcontractor
TBD
Subcontract Laboratory QA Manager
Ms. Dorothy Leeson
Surveyor
TBD

1.1.3 URS QA Officer

The QAO, Dr. Rosa Gwinn, PhD, is responsible for implementation of both the URS QA Manual (incorporated by reference) and this QAPP in both field and laboratory operations. The Project Manager delegates to the QAO the authority to take any actions necessary to ensure the reliability and validity of work and deliverables according to this QAPP. The QAO has, by definition, a level of authority coequal to that of the Field Manager and Laboratory QA Manager. She is responsible for developing and implementing procedures to appropriately document all project activities, to provide specific means of measuring conformance to specifications, managing the corrective actions program, and providing periodic reports to management. Specific responsibilities include:

- Develop, document, and carry out QA activities to ensure that appropriate QC measures are being carried out and documented;
- Ensure all records related to quality assurance are documented and maintained securely and retrievably;
- Conduct periodic performance audits and/or surveillances to measure conformance to specifications;
- Prepare periodic quality reports and QA sections of final reports;
- Ensure corrective actions are carried out and documented in a way that precludes future occurrences;
- Review and approve SOPs, training records, and purchasing actions; and,
- Acquire and maintain required certifications, and manage performance evaluation tests.

1.1.4 URS Certified Industrial Hygienist

The certified industrial hygienist, Ms. Patsy Glinsmann, is responsible for developing the Site Safety and Health Plan (SSHP). She is also a point of contact for any site emergency.

1.1.5 URS Field Manager/Field Geologist

The URS Field Manager, Mr. Jerry Kashatus, is responsible for the day-to-day management of field operations. He schedules and plans the work activities, provides periodic reports on the progress of work, and completes the field logs and other forms of field documentation. He will work closely with the QAO to plan and schedule audits, if any, assure proper training of field personnel, and immediately communicate any situations that may affect the quality of work products. The Field Manager is responsible for assuring that the work

proceeds according to schedule, and bears responsibility for guaranteeing the technical quality of the work. Specific responsibilities include:

- Oversee and monitor performance of subcontractors;
- Plan the activities of and coordinate field personnel on specific assignments;
- Provide a liaison between the client, field, laboratory staff, and any other subcontractors;
- Effectively carry out the URS QA Program and this QAPP; and,
- Assure completion of corrective actions, as needed.

1.1.6 URS Project Chemist

The project chemist, Ms. Andrea Sansom, is responsible for assisting with all field work. She is also responsible for coordination with the laboratory and data verification, review, and validation as outlined in section 2.0 of this QAPP.

1.1.7 Laboratory QA Manager, Operations Manager, and Laboratory Director

The Laboratory QA Manager, Ms. Dorothy Leeson, is responsible for QA/QC in all aspects of Severn Trent Laboratories (STL) operations. Her responsibilities include:

- Ensures that laboratory staff use recognized procedures and accepted laboratory practices;
- Ensures that staff conduct appropriate instrument maintenance and calibrations;
- Method development and documentation of procedures;
- Ensures compliance with applicable analytical methodology, strict adherence to Standard Operating Procedures (SOPs) and QA/QC requirements;
- Guarantees the technical accuracy and quality of the work;
- Ensures appropriate documentation of laboratory methods; and
- Ensures that all laboratory records are maintained securely and retrievably.

The Operations Manager is responsible for scheduling of samples and group assignments. The Laboratory Director and the Operations Manager are responsible for the provision of sufficient equipment, space, resources, and personnel to carry out the programs of the QAPP.

1.1.8 Direct Push Contractor

The direct push subcontractor is responsible for providing a direct push soil sampling rig, and personnel to operate the rig, along with all of the equipment necessary to complete the collection of the direct push soil samples.

1.1.9 Technicians and Analysts

Field staff and analysts are responsible for executing their work assignments in strict conformance to documented procedures and for the immediate identification of any conditions adverse to the quality performance of the work or work products. They are responsible for acquainting themselves with the technical requirements of any work assigned and seeking training or guidance as necessary to comply with those requirements. They are responsible for documenting their activities according to established procedures and reviewing their own work and the work of others presented to them for peer review. They will immediately cause work to cease on any activity that in their judgment does not meet applicable quality and safety standards, will appropriately document and report such conditions to management and will be active in the resolution of any such conditions. Specific responsibilities include the following:

- Ensure that all work is performed according to the applicable specifications;
- Ensure that QC measures are being carried out and documented;
- Ensure the quality of work and work products; and,
- Communicate QA and safety concerns to management.

1.2 ORGANIZATION

Figure 1-1 presents the organization chart for this project.

2.0 DATA ASSESSMENT ORGANIZATION AND RESPONSIBILITIES

2.1 DATA VERIFICATION

Data verification is the most basic assessment of data. Data verification is a process for evaluating the completeness, correctness, consistency, and compliance of a data package against a standard or contract. In this context, "completeness" means all required hardcopy and electronic deliverables are present. Data verification shall be performed by URS for primary laboratory deliverables and by the government or independent entity for QA laboratory deliverables.

2.2 DATA REVIEW

Data review is the next step in the data assessment hierarchy. Data review is the process of data assessment performed to produce the Chemical Quality Assurance Report (CQAR). Data review includes an assessment of the summary QC data provided by the laboratory. Data review shall be performed by URS for primary laboratory deliverables and by the government or independent entity for QA laboratory deliverables.

2.3 DATA VALIDATION

Data validation is a process of data assessment in accordance with U.S. Environmental Protection Agency (USEPA) Region III, Innovative Approaches for Validation of Organic and Inorganic Data - Standard Operating Procedures, June 1995. The review performed will be based on the organic level M-3 and inorganic level IM-2. Modifications reflect the level of review requested, the specifications of the project-specific QAPP, and the specifics of the analytical method employed. Data validation includes assessment of the whole raw data package from the laboratory. Data validation shall be performed by URS for primary laboratory deliverables and by the government or independent entity for QA laboratory deliverables.

2.4 DATA EVALUATION

Data evaluation is the process of data assessment done by district project chemists to produce a Chemical Data Quality Assessment Report (CDQAR). Data evaluation is performed to determine whether the data meet project-specific data quality objectives (DQO) and contract requirements. To prepare a CDQAR, the USACE district project chemist relies upon the DQO summary, the CQAR, field oversight findings, laboratory audits, sample results, and other data quality indicators available.

3.0 DATA QUALITY OBJECTIVES (DQOs)

3.1 DATA USE BACKGROUND

The objective of this remedial investigation at the Former Pesticide Shop (Building 6621) is to collect sufficient information to characterize the nature and extent of any contamination resulting from past practices in support of a human health and ecological risk assessment where previous soil investigations have revealed elevated levels of pesticides. Sampling will be conducted as outlined in the FSP. Surface and subsurface soil samples and groundwater will be collected and analyzed for organochlorine pesticides (SW846 8081A), organophosphorous pesticides (SW846 8141A), and arsenic and chromium (SW846 6010B Trace or SW6020). The field samples collected per the FSP will be shipped via overnight express to off-site laboratory for analysis.

3.2 MEASUREMENT QUALITY OBJECTIVES FOR CHEMICAL DATA

Table 3-1 provides a tabular summary of the sampling and analysis program. Quality assessment provisions are described in detail in Sections 2 and 8 of this document. The overall goal is to carry out procedures for sample collection, analysis, evaluation, and reporting that will meet the objectives for the program as established by the client in association with the project team. QA objectives will be achieved through the implementation of specific procedures for sampling, field data collection, chain-of-custody, laboratory analysis, calibration, internal quality control, audits, preventive maintenance and corrective actions as described in this QAPP. Sampling and analytical methodologies are chosen based on the intended use and data quality requirements of the work. The purpose of this section is to broadly define minimum QA goals for precision, accuracy, representativeness, completeness, comparability, and sensitivity of the laboratory measurements. More specific information regarding data quality indicators, including matrix specific QC criteria and detection limits for individual analytes are presented in the Laboratory QA Manual and/or SOPs for the methods of analysis specified in Table 3-1 and Appendix C.

3.2.1 Definitive

Definitive data are quantitative and provide confirmation of analyte identification on an analyte specific basis. They are usually generated using published analytical methods. These data are documented rigorously with detailed QA/QC information provided in addition to detailed sample specific information, allowing for independent review. Soil analytical measurements for arsenic and chromium by 6010B Trace; aqueous analytical measurements for arsenic and chromium by SW6020; and, soil and aqueous analytical measurements for organochlorine pesticides by SW8081A and organophosphorous pesticides by SW8141A will be defined as definitive in nature.

3.2.2 Screening

Screening level data are generally developed using less rigorous analytical methods. The data may provide indications of contamination, be semi-quantitative, and may not be analyte specific. To be considered data of known quality, screening level measurements must be confirmed by definitive methods. No screening data will be generated for the purposes of this project.

TABLE 3-1
Summary of the Sampling and Analysis Program

Medium	Anticipated Number of Field Samples*	Target Analytes	Laboratory Analyses
Surface Soil	35	Arsenic and Chromium	SW6010B Trace
		Organochlorine Pesticides	SW8081A
		Organophosphorous Pesticides	SW8141A
Subsurface soil	66	Arsenic and Chromium	SW6010B Trace
		Organochlorine Pesticides	SW8081A
		Organophosphorous Pesticides	SW8141A
Groundwater	4	Arsenic and Chromium	SW6020
		Organochlorine Pesticides	SW8081A
		Organophosphorous Pesticides	SW8141A

*Number of field samples does not include field QC samples. The frequency of field QC samples will be as follows: (1) Rinsate blanks - 1 per 20 samples per matrix; (2) MS/MSDs - 1 pair per 20 samples per matrix; (3) Field duplicates - 1 per 20 samples per matrix; and, (4) QC Split - to be determined by the client.

3.3 QA OBJECTIVES FOR MEASUREMENT

3.3.1 Accuracy

Accuracy means agreement between a known value and a measured value. This is normally expressed as percent recovery (%R) of a surrogate, matrix spike, and/or analytical control sample.

The accuracy objectives are noted in Table 6-1 and 6-2. The Laboratory Manager will be responsible for compliance with accuracy objectives. Should any of the data fail the accuracy criteria, corrective action will be taken as described in the method, the relevant SOPs, or according to the provisions of Section 5.5. Peer and senior review of work products will be provided as a check on measurement accuracy.

$$ACCURACY = \frac{MEASURED\,VALUE}{KNOWN\,VALUE} \text{ x } 100$$

3.3.2 Precision

Precision is agreement among individual measurements of the same property under similar conditions. Precision is tested through the use of field and laboratory duplicate or replicate analyses. It is usually expressed as either relative percent difference (RPD) or percent relative standard deviation (%RSD) between duplicates, replicates, or matrix spike pairs.

$$RPD = \left\{ \frac{|X_1 - X_2|}{[(X_1 + X_2)/2]} \right\} x \quad 100\%$$

$$RSD = \left(\frac{[std\ dev]}{\overline{X}} \right) x\, 100\%$$

$$\sqrt{[std\ dev]} = \left[\sum \frac{(X_i - \overline{X})^2}{(n-)1} \right]$$

The precision objectives are noted in Table 6-1 and 6-2. The Laboratory Manager will be responsible for compliance with precision objectives for laboratory duplicates and matrix spike pairs. Should any of the data fail the precision criteria, corrective action will be taken as described in the method, the relevant SOPs, or according to the provisions of Section 5.5. Peer and senior review of work products will be provided as a check on measurement accuracy.

3.3.3 Representativeness

Representativeness is a measure of the degree to which the measured values accurately and precisely reflect the medium being sampled. Representativeness is largely the result of the appropriate selection of sampling locations and sampling methods. It is assessed through the comparison of field duplicate sample data to the original sample data and the review of blanks. Should any of the data fail the representativeness criteria, corrective action will be taken as described in the method and the relevant SOPs. Peer and senior review of work products will be provided as a check on laboratory representativeness.

3.3.4 Completeness

Completeness is a measure of the amount of valid data obtained compared to the amount of valid data expected to be obtained under normal conditions.

$$COMPLETENESS = \frac{QUANTITY\ OF\ VALID\ DATA}{TOTAL\ QUANTITY\ OF\ DATA} \times 100$$

The overall analytical completeness goal for this project is 95 percent (i.e., 95 percent of the laboratory data should be valid (usable) for their intended purposes). The QAO will be responsible for monitoring the completeness objectives. Should any of the data fail the completeness criteria, corrective actions will be considered such as resampling and/or reanalysis.

3.3.5 Comparability

Comparability is the confidence with which one data set can be compared to another. Comparability will be controlled by using SOPs developed to standardize the collection of samples and acquisition of measurements. Consistent, proper calibration of all equipment throughout the field exercises, as described in this QAPP, will help in maintaining the comparability of measurements. Field documentation and QA audits will be used to establish that protocols for sampling and measurement follow appropriate SOPs.

3.3.6 Sensitivity

Analytical detection limits (sensitivity) should be low enough to confirm the presence or absence of a given analyte at a concentration less than a predetermined comparison criteria, at specified levels of precision and accuracy. General reporting limits, which are highly matrix dependent, are presented in Table 6-1 and 6-2.

3.4 SPECIAL TRAINING REQUIREMENTS/CERTIFICATION

In addition to health and safety training as required for hazardous site workers by the Occupational Safety and Health Administration, field personnel will receive technical training in the techniques they are expected to carry out. Training will consist of, at a minimum, on the job training by a senior staff member in the SOPs they are expected to implement, documented by virtue of a signed copy of the cover sheet for the FSP. Said documentation will be retained on file by the QAO.

Laboratory analysts will receive appropriate training in procedures, safety, and waste disposal. The Laboratory Group Leaders, or their designees, will train all analysts on analytical methods and operation of laboratory instrumentation. All analysts will be required to prove the ability to execute methods they perform with acceptable precision and accuracy through analysis of performance evaluation samples in quadruplicate which meet the applicable QC standards of the method. Training completed by the analyst will be documented by the Laboratory QA

Manager and maintained on file. These records will serve the additional purpose of providing for validation of non-standard methods of analysis.

4.0 DOCUMENTATION, SAMPLE RECEIPT, HANDLING, CUSTODY AND HOLDING TIME REQUIREMENTS

4.1 DOCUMENTATION AND RECORDS

Bound logbooks and electronic run logs will be used for all record keeping purposes both in the field and laboratory with the exception of certain standard forms that will be maintained in three ring binders or file folders. All logbooks and binders will contain a unique document control number. All pages, including loose-leaf forms, will be numbered.

Field personnel will transmit the bound logbooks to the Field Manager (or their designees) on a routine basis. Original logbooks will be reviewed at a frequency not to exceed once every week, by the Field Manager, who will sign the logbook as proof of said review. Laboratory personnel will transmit the bound logbooks to peers on a routine basis. Original logbooks will be reviewed at a frequency not to exceed once every quarter, by the peer, who will sign the logbook as proof of said review.

To ease data review, the person making an entry must sign and date the entry. All entries must be recorded in permanent ink. Correction to entries will be made by drawing a line through the incorrect entry, recording the correct information, and initialing and dating the corrected entry. If the reason for making the change is not immediately evident, an explanation is required. Unused portions of logbook pages must be lined out.

If computerized information is used, a hard copy that has been permanently affixed to the logbook will be acceptable as an original record of sampling and/or laboratory logging

4.1.1 Field Records

Field records, including sample collection records, chain of custody records, etc. will be maintained according to the FSP. At a minimum, all field personnel will keep a personal log of activities, noting any conditions that in their judgment may bear on the use or interpretation of the data they acquire.

4.1.2 Laboratory Records

4.1.2.1 Laboratory Log In. Once samples have been received by the laboratory, they will be logged into the laboratory's Laboratory Information Management System (LIMS) or into a bound laboratory notebook. Minimum information content for log in includes:

- Field sample number;
- Laboratory receipt date;
- Chain of Custody status;
- Condition in which sample arrived (i.e., intact, cracked lids, frozen, etc.);
- Analyses requested;

- Other pertinent observations including temperature, preservation status, appearance, etc.

4.1.2.2 Reference Materials. Bound logbooks must be maintained of all reference materials used for analytical purposes. This will include records of all dilutions or other standard preparation steps such that all standards used during analysis will be traceable to purchased certified standards. The record must include the following information:

- Date of receipt;
- Source;
- Purity;
- Unique identification numbers;
- Record of dilutions/preparation referencing original standard ID number; and,
- An expiration date.

4.1.2.3 Sample Preparation. Personnel involved in doing sample extraction, digestion or other sample preparation techniques must maintain a record of those activities in a bound logbook. Although this logbook must be specific to the operation, it need not be operator specific. The logbook should be signed and dated daily and contain the following information:

- Samples prepared, including date and time, analysis, weights or volumes involved at beginning and end of process;
- Standards and reagents used;
- QC samples prepared with the batch and the reference values of the standards if applicable;
- Procedures used; and
- Relevant calculations and other relevant observations such as color, foaming, gas generation, etc.

4.1.2.4 Instrument Operation. Each instrument must have a dedicated logbook. Information in the logbook must reflect routine and emergency maintenance activities, tuning, calibration, and all analytical activities conducted on the instrument. A new page must be started daily during equipment operation. Information to be included for each page consists of:

- Date, operator, and project name;
- Description of any instrument maintenance or modification;
- Tuning and calibration activities;
- Instrument settings;
- Instrument operating conditions; and
- Samples analyzed including QA/QC samples and the results of each if separate instrument printouts are not provided. The use of automated data acquisition systems will require recording a reference to the data file for each standard or sample.

Hard copy data output from integrators and chromatograms should have the following information on the printout:

- Analysis date and time;
- Test name and sample number;
- Reference to the calibration curve used for quantitation;
- Logbook reference to recorded analytical activities; and
- Identification of chromatographic peaks.

4.2 SAMPLE HANDLING AND CUSTODY REQUIREMENTS

Field personnel will, at all times, be aware of the need to maintain all samples, whether in the field or in the laboratory, under strict chain of custody. A sample is in the custody of a person if it is in his possession, within his view, or secured by him in a location accessible only to authorized personnel. Chain of custody provisions as defined in the FSP are applicable to all off-site shipments of samples. An example of a typical chain-of-custody form is provided as Figure 4-1.

Samples received in the laboratory will be received under chain of custody and will be defined as in a secure location while within the confines of the laboratory. Laboratory facilities will be locked (i.e., electronic keys) to assure only authorized entry. Custody will be terminated by filing manifests and/or shipping documents upon clean disposal.

4.2.1 Sample Receipt

Samples delivered to the fixed-base laboratory will be received and processed in accordance with the provisions of the laboratory QA Manual and SOPs (Appendix C). The temperature is measured from a temperature blank from each cooler as soon as possible after receipt and recorded on to a Cooler Receipt Form. The QAO or project chemist will be notified immediately with regard to samples that fail to meet temperature criteria ($4 \pm 2\ ^{o}C$).

4.2.2 Corrective Action for Incoming Samples

The Laboratory Manager or his designee (Project Manager) will contact the Field manager each day to verify laboratory receipt of samples sent the previous day and to coordinate sample receipts for the current day. The Laboratory Manager will inform the data user of any problems observed with the previous day's shipment (e.g., breakage, inconsistencies with chain-of-custody and actual numbers received), at which time corrective action will be carried out by agreement between the parties. Said agreement to be documented in the form of a telephone conversation log entry.

Figure 4-1
Chain of Custody Form

CHAIN OF CUSTODY RECORD PAGE OF

SAMPLER (Signature) DATE SHIPPED CARRIER

PHONE AIRBILL NO. COOLER NO.

SHIP TO

LABORATORY NAME

ADDRESS

PHONE NO.

ATTENTION

RESULTS TO

CLIENT NAME

COMPANY

ADDRESS

PHONE NO.

PROJECT NAME PROJECT NO. PO NO

RELINQUISHED BY (Signature)	RECEIVED BY (Signature)	DATE	TIME
RELINQUISHED BY (Signature)	RECEIVED BY (Signature)	DATE	TIME
RELINQUISHED BY (Signature)	RECEIVED BY (Signature)	DATE	TIME
RELINQUISHED BY (Signature)	RECEIVED BY (Signature)	DATE	TIME

ANALYSIS REQUEST

SAMPLE NO.	ID	SAMPLE DESCRIPTION	DATE / TIME SAMPLED	ANALYSIS REQUESTED	SAMPLE RECEIPT CONDITION

SPECIAL INSTRUCTIONS / COMMENTS

EXPECTED ANALYTICAL T.A.T'S Immediate Attention Rush Standard

LOG NUMBER (laboratory use only)

4.2.3 Sample Holding Times

Sample holding time, (the time between sampling and sample preparation and/or analysis), in which a sample can be considered valid and representative of the sample matrix, is specific to the analytes of interest and the method of analysis employed. Although holding times will not generally be at issue in a field measurement where samples are to be analyzed on the day of receipt, the allowable holding times for the analyses performed in the off-site laboratory are presented in Table 4-1. The Operations Manager is responsible for sample tracking and to ensure that holding times are not exceeded.

TABLE 4-1
Sample Containers, Preservation, and Holding Times

Test Type	Container	Preservation	Holding time
SW6010B Trace, soil	4 oz glass jar	Cool to 4°C ± 2°C	180 days
SW6020, aqueous	250 ml polyethylene jar	HNO_3 to pH <2, Cool to 4°C ± 2°C	180 days
SW8081A , soil	8 oz. wide-mouth glass	Cool to 4°C ± 2°C	14 days to extraction 40 days to analysis
SW8081A, aqueous	2-1L amber glass	Cool to 4°C ± 2°C	14 days to extraction 40 days to analysis
SW8141A , soil	8 oz. wide-mouth glass	Cool to 4°C ± 2°C	14 days to extraction 40 days to analysis
SW8141A, aqueous	2-1L amber glass	Cool to 4°C ± 2°C	14 days to extraction 40 days to analysis

5.0 ANALYTICAL PROCEDURES

Analytical methodologies will be based on current USEPA methods, other published sources, or on manufacturer's recommendations in the case of certain semi- or non-quantitative measurements. Table 5-1 presents a listing of the analytical methods applicable to this work and the source of guidance for that method. All analytical methods are documented in SOPs, reviewed and approved by the Laboratory QA Manager or his designee.

TABLE 5-1
Methods of Analysis

Test Type	Sample Preparation/Analysis Method
Arsenic and Chromium, soil	SW-846 Method 3050B/6010B Trace
Arsenic and Chromium, aqueous	SW-846 Method 3010A/6020
Organochlorine pesticides , soil	SW-846 Method 3540C or 3550B/8081A
Organochlorine pesticides, aqueous	SW-846 Method 3510C or 3520C/8081A
Organophosphorous pesticides , soil	SW-846 Method 3540C or 3550B/8141A
Organophosphorous pesticides, aqueous	SW-846 Method 3510C or 3520C/8141A

Subsampling (i.e., the selection of analytical aliquots) will be performed using standard methods. Field submitted samples will be homogenized through gentle agitation (in the case of aqueous samples) prior to selecting the analytical aliquot or through a cone and quartering technique for soils.

Sample preparation will be performed according to SOPs based on standard methods or manufacturer's recommendations. For the fixed-base laboratory, details are provided in Appendix C. Sample preparation will be documented according to the provisions of Section 4.1.2 including documentation of all standards and reagents employed, the known values of all standard and spiking mixtures employed with cross references to appropriate dilution log entries, and notation of any pertinent observations by the analyst.

5.1 INSTRUMENT/EQUIPMENT TESTING, INSPECTION, AND MAINTENANCE REQUIREMENTS

All equipment and supplies purchased in support of these activities will be purchased according to the provisions of this plan, which requires a documented review of the vendor and equipment selection process and receipt inspection and/or testing as appropriate.

In summary, those procedures require that new equipment be tested with an appropriate standard or standards to ensure they function according to their intended use. Quality control sample results from initial field use of all equipment and supplies will be reviewed by the Field Manager, Group Leaders or their designees to identify any cause for concern regarding new equipment and supplies received. Corrective actions will be implemented and documented according to the provisions of Section 5.5 as required.

Instrument maintenance, both routine and preventive, will be performed according to manufacturers' instructions. A preventive maintenance plan allows for periodic instrumentation checks for problems that occur frequently. The objective of a preventive maintenance plan is to rectify equipment problems before they become serious. Preventive maintenance also brings attention to those areas of the instrument susceptible to degradation from aging, toxic/corrosive attack, and clogging due to environmental factors.

Procedures for preventive maintenance are contained in each instrument's manual under the maintenance/troubleshooting sections. Logbooks, such as those described in Section 7, will be maintained for each instrument used in the laboratory. Maintenance, calibration, and performance data will be entered by the operator and will be periodically reviewed by the Field/ Laboratory Manager.

An inventory of critical spare parts will be maintained on-site during all field activities. Critical spare parts are defined as those that would cause a delay in field or laboratory activities of greater than 4 hours upon failure. The specific needs of the program will be determined at the discretion of the Field/Laboratory Manager.

5.2 INSTRUMENT CALIBRATION AND FREQUENCY

An instrument calibration establishes a reproducible reference point to which all sample measurements can be correlated. The analytical method mandates the frequency of instrument calibrations. Laboratory calibration standards will be traceable to their sources. Documentation of all standards used and their preparation will be included in the Standards Log referenced in Section 7.

Routine calibrations are required for most forms of analytical instrumentation. An initial calibration is performed before sample analysis. Where appropriate, retention time windows will be established for each compound of interest following the protocol in SW-846, 8000B. For SW6010B, a one-point calibration may be used in conjunction with a low-level check standard at the method quantitation limit (MQL). Otherwise a 3-point calibration curve will be established for quantitative analyses using SW6010B. Calibrations will be verified by using independent standards as a QC check sample, calibration verification sample, or fully processed Laboratory Control Samples (LCSs).

For quantitative analyses, a continuing calibration check (midpoint calibration standard) will be analyzed periodically according to the provisions of the applicable SOP. All analytical sequences will end with a calibration verification, although occasionally, where sequential work shifts are employed, the second shift continuing calibration will serve as the end of shift check for the first shift.

All calibrations are documented in the run logs and are stored with the project files after completion of the project. Calibration acceptance criteria and corrective actions can be found in Tables 5-2a, 5-2b, and 5-2c.

5.2.1 Reference Materials

Reference standards are required to generate certification data, calibrate instruments, spike analytical surrogates or standards, and prepare QC samples. These solutions must be of known concentration and purity to be useful in assessing the quality of analytical data.

Standards used to conduct analyses will be either Standard Analytical Reference Materials (SARMs), Interim Reference Materials (IRMs), or purchased, certified standards. SARMs developed and distributed by the Central QA Laboratory of the National Institute of Standards and Technology (NIST) will be the preferred standard. IRMs are not as rigorously characterized as SARMs. In any case, second source verification of standards will be required.

Material safety data sheets (MSDSs) for all standards and reagents will be stored on-site. It is the responsibility of the Laboratory Manager and all personnel to know where MSDSs are stored and to be familiar with the content of the most commonly used chemicals in the laboratory environment.

Reference materials for organic analyses are stored per manufacturer guidelines. When purchased standards are used to create stock standards and subsequent dilutions for calibration and spiking, the standards log must be filled out by the analyst according to the provisions of Section 7. Newly created standards will be labeled with a unique identification number, the analyte(s), concentrations, date created, and an expiration date. Newly created standards will be analyzed against existing standards and are expected to agree to within method accuracy requirements. If this test fails, the analyst must investigate the problem to identify which standard is deficient. If the new standard is deficient, the entry in the standards log will be voided and new standard prepared. If the old standard appears to have degraded, the Operations Manager or QA Manager are to be notified to assess the impact to the quality of related analyses. Corrective action will be followed and documented in accordance with the provisions of Section 5.5.

TABLE 5-2a
QC Specifications for Analysis
Laboratory Measurements using SW6010B Trace or SW6020

Test Type	Description of Element	Frequency	Criteria	Corrective Action
Initial Calibration	Option 1- 1 std and blank, and a low-level check std at MQL Option 2- 3 stds and blank	Daily	Option 1- Low level check standard ±20% Option 2- r ≥ 0.995	maintenance, repeat
Instrument Precision	%RSD 2 integrations (exposures)	Each calibration and calibration verification std (ICV/CCV)	%RSD < 5%	maintenance, repeat sequence
Initial Calibration Verification (ICV)	Midlevel (2nd source) verification	After initial calibration	%Recovery ± 10%	maintenance, repeat
Initial Calibration Blank (ICB)	Interference-free matrix to assess analysis contamination	After initial calibration verification	Analytes < MDL	maintenance, repeat
Interelement Check Standards (ICS)	ICSA - interferents only ICSB - interferents and target analytes	Beginning of analytical sequence	%Recovery ± 20% for target analytes	maintenance, repeat tests
Continuing Calibration Verification (CCV)	Midlevel verification	every 10 samples and end of sequence	%Recovery ± 10%	new initial calibration, repeat tests
Continuing Calibration Blank (CCB)	Interference-free matrix to assess analysis contamination	following CCV every 10 samples and end of run	Analytes < MDL	maintenance, repeat tests
Method Blank (MB)	Interference-free matrix to assess overall method contamination	1 per sample batch[1]	Analytes < MRL	reprep and reanalyze
Laboratory Control Spike (LCS)	Interference-free matrix containing all target analytes	1 per sample batch[1]	%Recovery ± 20%	reprep and reanalyze
Matrix Spike (MS)	Sample matrix spiked with all target analytes prior to digestion	1 per sample batch[1]	%Recovery ± 25%[3]	A matrix effect may be present, use in concert with PDS and SD to determine if MSA is required
Matrix Duplicate (MD) or Matrix Spike Duplicate (MSD)	If target analytes are present, use MD If target analytes are not present, use MSD	1 per sample batch[1]	RPD ≤ 25%[2]	A matrix effect may be present, use in concert with PDS and SD to determine if MSA is required
Post Digestion Spike (PDS)	Sample digestate spiked with all target analytes	1 per sample batch[1] on MS sample	%Recovery ± 25%[3]	A matrix effect may be present, use in concert with MS, MD, MSD and SD to determine if MSA is required
Serial Dilution (SD)	1:4 dilution analyzed to assess matrix effects	As needed to assess new and unusual matrices	Agreement between undiluted and diluted results ± 10%	A matrix effect may be present, use in concert with MS, MD, MSD and PDS to determine if MSA is required
Method of Standard Additions (MSA)	Method of quantitation	As needed for samples with suspected or confirmed matrix effects	r ≥ 0.995	

[1]A sample batch consists of no more than twenty field samples. [2]USEPA National Functional Guidelines 5X rule applies. [3]USEPA National Functional Guidelines 4X rule applies.

TABLE 5-2b
QC Specifications for Analysis
Laboratory Measurements using SW8081A

Test Type	Description of Element	Frequency	Criteria	Corrective Action
Breakdown Evaluation	Standard with a known concentration of DDT and Endrin	Beginning and end of every sequence or more frequent	% Breakdown $\leq$ 15% for each DDT and Endrin	maintenance, repeat
Initial Calibration	5 standards of varying concentrations, low point at or above the MRL, that define the linear range	As often as required to maintain passing calibration verification criteria	r $\geq$ 0.995, %RSD $\leq$ 20%, r2 $\geq$ 0.990	maintenance, repeat
Initial Calibration Verification (ICV)	Midlevel (2nd source) verification	After initial calibration	%Recovery $\pm$ 15%	maintenance, repeat
Continuing Calibration Verification (CCV)	Midlevel verification	Prior to every ten samples	verify % drift or difference is $\leq$ 15%	new initial calibration, repeat tests
Method Blank (MB)	Interference-free matrix to assess overall method contamination	1 per sample batch[1]	Target Analytes < MRL	reextract and reanalyze
Laboratory Control Spike (LCS)	Interference-free matrix containing known concentrations of all target analytes, excluding toxaphene and technical chlordane, spiked prior to extraction	1 per sample batch[1]	Aqueous % recovery: See Table 6-2 Soil % recovery: See Table 6-1 Sporadic Marginal Failure: 30-150%	reextract and reanalyze
Matrix Spike (MS)/Matrix Spike Duplicate (MSD)	Sample matrix spiked with known concentrations of all target analytes, excluding toxaphene and technical chlordane, spiked prior to extraction	1 per sample batch[1]	Aqueous % recovery: See Table 6-2 Soil % recovery: See Table 6-1 Sporadic Marginal Failure: 30-150% RPD $\leq$ 50% Sporadic Marginal Failure: $\leq$ 60%	reextract and reanalyze if recovery is less than 10%
Surrogate	The compound tetrachloro-m-xylene spiked into sample prior to extraction to assess the extraction efficiency	Every sample	Aqueous % recovery: 39-130% Soil % recovery: 31-131%	Not applicable
Target Analyte Confirmation	Alternate calibrated column or detector	Every detection above the MDL	RPD $\leq$ 40%	Report the higher of the two concentrations, unless a visible positive interference is present.

[1]A sample batch ***or sample delivery group (SDG),*** consists of no more than twenty field samples. [2]USEPA National Functional Guidelines 4X rule applies.

TABLE 5-2c
QC Specifications for Analysis
Laboratory Measurements using SW8141A

Test Type	Description of Element	Frequency	Criteria	Corrective Action
Initial Calibration	5 standards of varying concentrations, low point at or above the MRL, that define the linear range	As often as required to maintain passing calibration verification criteria	r $\geq$ 0.995, %RSD $\leq$ 20%, r2 $\geq$ 0.990	maintenance, repeat
Initial Calibration Verification (ICV)	Midlevel (2nd source) verification	After initial calibration	%Recovery $\pm$ 15%	maintenance, repeat
Continuing Calibration Verification (CCV)	Midlevel verification	Prior to every ten samples	verify % drift or difference is $\leq$ 15%	new initial calibration, repeat tests
Method Blank (MB)	Interference-free matrix to assess overall method contamination	1 per sample batch[1]	Target Analytes < MRL	reextract and reanalyze
Laboratory Control Spike (LCS)	Interference-free matrix containing known concentrations of ethyl parathion, methyl parathion, and disulfoton spiked prior to extraction	1 per sample batch[1]	Aqueous % recovery: See Table 6-2 Soil % recovery: See Table 6-1 Sporadic Marginal Failure: 30-150%	reextract and reanalyze
Matrix Spike (MS)/Matrix Spike Duplicate (MSD)	Sample matrix spiked with a known concentrations of ethyl parathion, methyl parathion, and disulfoton spiked prior to extraction	1 per sample batch[1]	Aqueous % recovery: See Table 6-2 Soil % recovery: See Table 6-1 Sporadic Marginal Failure: 30-150% RPD $\leq$ 50% Sporadic Marginal Failure: $\leq$ 60%	reextract and reanalyze if recovery is less than 10%
Surrogate	The compound triphenyl phosphate spiked into sample prior to extraction to assess the extraction efficiency	Every sample	Aqueous % recovery: 51-137% Soil % recovery: 71-133%	Not applicable
Target Analyte Confirmation	Alternate calibrated column or detector	Every detection above the MDL	RPD $\leq$ 40%	Report the higher of the two concentrations, unless a visible positive interference is present.

[1]A sample batch ***or sample delivery group (SDG),*** consists of no more than twenty field samples. [2]USEPA National Functional Guidelines 4X rule applies.

5.3 FIELD AND LABORATORY QUALITY CONTROL REQUIREMENTS

Field programs will include the collection and analysis of appropriate types of quality control samples. For purposes of this program the following field QC samples will be used: field duplicates and rinse/equipment blanks. Matrix spike/matrix spike duplicate samples are required by the methods of analysis proposed and additional field sample will be provided to the laboratory for this purpose as required. This section describes the method of collection and typical frequency of collection for field quality control samples. In addition, laboratory QC samples are also analyzed to establish the precision, accuracy, and representativeness of results. This section also describes the QC samples associated with each type of analysis, the acceptance criteria for each QC check, and the corrective actions taken if criteria are not met.

5.3.1 Field QC Samples

Duplicate samples will generally be taken from areas known or suspected to be contaminated at a frequency equal to 5% of all field samples. When appropriate to the method, matrix spike/matrix spike duplicates will also be collected at a frequency of 5% each. Soil sample duplicates/splits are collected and homogenized before being split. Field duplicate results must be assessed by the data user. No corrective action is taken in the laboratory based on field duplicate results.

Rinse/equipment blanks will be collected when the sampling equipment is decontaminated and reused in the field or when a sample collection vessel (bailer or beaker) will be used, at a frequency of one per twenty decontamination events. The equipment used in sampling will be rinsed with analyte free water and the water running off the equipment will be collected in sample containers.

Field submitted blank results are assessed by the data user. No corrective actions are taken by the laboratory based on field submitted blanks.

5.3.2 Laboratory QC Samples

Tables 5-2a, 5-2b, and 5-2c presents the laboratory QC samples analyzed for the method, the frequency at which those QC checks are made, the acceptance criteria applied, and the corrective action taken if acceptance criteria are not met. QC data are maintained for periodic review by the QAO. The QAO, as a part of his periodic report to the Project Manager, will identify any areas of concern for formal corrective action according to the provisions of Section 5.5.

5.4 AUDITS/SURVEILLANCES

This section discusses performance and system audits/surveillances used to monitor the capability and performance of the total measurement system and to evaluate the quality of field and laboratory operations. A performance audit is a planned independent check of the operation of a system to obtain a measure of the quality of data generated. It involves the use of standard

reference samples or materials certified as to their chemical composition or physical characteristics. System audits are of a qualitative nature and consist of on-site review of a system's quality assurance system and physical facilities for sampling/analysis, calibration, and measurement. Less formal surveillance may also be executed to assess conformance of field and laboratory staff to work specifications. The QAO will be responsible for auditing field activities and the field analytical laboratories at a frequency agreed upon with the Project or Laboratory Manager.

5.4.1 Field System Audits

If authorized by the client, a field QA audit will be conducted during the first few days of each major field activity to learn if the field teams are following protocols delineated in the PCDs. The QAO will assess conformance to the following general provisions using a check list based on site specific PCDs:

- Copies of the Site-Specific Safety and Health Plan, FSP, and QAPP, including all appropriate SOPs, are on-site and accessible to the sampling and analysis teams;
- The field instruments are of the proper type, and have been properly maintained and calibrated;
- Appropriate documentation is maintained according to agreed upon specifications;
- Sample collection and analysis procedures are executed per the QAPP and FSP;
- Sample handling procedures are executed properly;
- Chain-of-custody forms include all information listed in the SOP, and;
- Sampling equipment is properly decontaminated per the QAPP and FSP.

During the audit, appropriate actions will be taken by the QAO to ensure that field sampling is conducted according to this QAPP and the Workplan or FSP. The QAO will document any deficiencies encountered during the audit and any actions taken in the field to correct potential problems. Results of the audit will be maintained at the URS office in Gaithersburg, MD, as part of the QA documentation.

Upon completion of the audit, a report of the findings will be given to the Project Manager. Deficiencies encountered will be listed in the report and the corrective action recommended/ taken to rectify the problem.

5.4.2 Laboratory System Audits

The URS QAO may perform laboratory audits to assess compliance with the provisions of this QAPP. In the event that the client authorizes such an audit, the QA manager will inspect

the laboratory's facilities to verify the adequacy and maintenance of instrumentation and the conformance of personnel to SOPs. The items to be checked include, but are not necessarily limited to:

- Size and appearance of the facility;
- Quantity, age, availability, scheduled maintenance and performance of instrumentation;
- Availability, appropriateness, and use of SOPs including QC provisions;
- Staff qualifications, experience, and personnel training programs;
- Reagents, standards, and sample storage facilities;
- Standard preparation logbooks and raw data;
- Bench sheets and analytical logbook maintenance and review;
- Review of the laboratory's sample analysis/data package inspection procedures; and
- Ensuring that all records, logs, SOPs, and analytical results are maintained securely and retrievably.

Upon completion of the laboratory audit, a report of the findings will be given to the Laboratory Manager. Deficiencies encountered will be listed in the report with the corrective action recommended/taken by the laboratory. Deficiencies found during the audit will immediately be relayed to the appropriate laboratory personnel for immediate corrective action.

5.4.3 Office Audits

The QAO will also conduct audits of the case files. These audits will determine the completeness of the files and verify that all of the appropriate information is included in the files.

5.5 NONCONFORMANCE/CORRECTIVE ACTION

To enhance the timeliness of corrective action and reduce the generation of unacceptable measurement data, problems identified by assessment procedures will be resolved at the lowest possible management level. Problems that cannot be resolved at this level will be reported to the QA Manager for resolution. The QA Manager will determine at which management level the problem can best be resolved, and will notify the appropriate manager. Periodic progress reports will detail all problems and subsequent resolutions.

The steps comprising this closed-loop corrective action system include:

- Defining the problem;
- Assigning responsibility for problem investigation;
- Investigating and determining the cause of the problem;
- Assigning responsibility for problem resolution; and
- Verifying that the resolution has corrected the problem.

Documentation of the condition requiring corrective action, assignment of responsibility for corrective action, due dates for completion of corrective action, and verification of

completion will be maintained. Such documentation will be reviewed during system audits. Figure 5-1 is a form for use by all project staff to document the identification and resolution of all corrective actions and field changes.

Process changes, including field changes, will be governed by control measures commensurate with those applied to the original sampling design. Field changes will be justified, documented and approved by the Project or Laboratory Manager or his designee. The control of changes to project work plans will be according to this requirement.

The QAO will provide periodic reports to the Project Manager including an overview of activities assessed, identifying any conditions adverse to quality, and stipulating corrective actions carried out and/or required. These reports will be provided at a frequency not to exceed once per quarter and will include as attachments, and as appropriate to the reporting period:

- Data validation findings;
- Audit/surveillance reports;
- Monthly status reports of QC activities;
- Corrective Action Requests and Resolutions; and,
- Other forms of control measurement documentation.

5.6 WASTE DISPOSAL

All generated wastes will be properly segregated and stored in properly labeled containers. Field generated waste will be handled according to the provisions of the site specific work plan and related SOPs. In the laboratory, analyses will be conducted in a way that keeps wastes to a minimum. It will be the responsibility of the site owner to properly dispose of all field and laboratory generated wastes.

5.7 DECONTAMINATION

Decontamination of field equipment will be accomplished according to the site-specific FSP. In general terms, decontamination will be performed on all equipment that will contact the sampled media before the start of work and between sampling locations. Decontamination will generally consist of a non-phosphate detergent and water wash followed by a series of rinses with tap water, deionized water, and air-drying. Equipment is stored in clean areas, wrapped in plastic or aluminum foil sheeting.

Disposable labware will be employed to the fullest extent possible. Laboratory supplies and equipment that are reused will be decontaminated using soap and water washes followed by repetitive rinses with demonstrated analyte free water and appropriate solvents. Using method blanks will show the cleanliness of labware and equipment.

Figure 5-1
Corrective Action Report Form

CORRECTIVE ACTION REPORT

Number **CAR-** Date

RECOMMENDATION

To

You are hereby requested to implement the actions indicated below and as otherwise determined by you (A) to improve the noted condition and (B) to monitor the improvements. Your written response is to be returned to the QAO by _____.

Subject:

Reference Documents:

Recommended Action:

Originator	Date	Approval	Date	Approval	Date

RESPONSE

Evaluation:

Action:

Monitoring Steps:

Affected Documents:

Signature	Date	QA Follow-up on Corrective Action:	Verified	Date

5.8 INSPECTION/ACCEPTANCE REQUIREMENTS FOR SUPPLIES AND CONSUMABLES

Materials and consumables will be inspected by the Field/Laboratory Manager and/or his representative against the purchase order specifications to verify their fitness for use. All materials received will be properly labeled and recorded on the inventory log for accuracy. An expiration date will be assigned immediately to all standards, reagents, and solvents.

Documentation concerning the quality of materials used on-site will be retained in the central files.

6.0 DATA REDUCTION/CALCULATION OF DATA QUALITY INDICATORS

6.1 PRECISION

The definition and calculations for precision are found in Section 3.3.2. In order to assess matrix homogeneity or sample collection protocol, field precision is determined from field duplicate samples. The laboratory precision may be determined from laboratory duplicate samples such as the matrix spike pair. The precision objectives are noted in Tables 5-2a, 5-2b, 5-2c, 6-1, and 6-2.

6.2 BIAS

Bias assessments are based on agreement between a known value and a measured value. This is normally expressed as percent recovery (%R) of a surrogate, matrix spike, and/or analytical control sample.

$$\text{Percent Recovery} = \frac{\text{MEASURED VALUE} - \text{UNSPIKED VALUE}}{\text{KNOWN VALUE}} \text{ x } 100$$

The bias objectives will follow the accuracy objectives as noted in Table 5-2a, 5-2b, and 5-2c. The Laboratory Manager will be responsible for compliance with accuracy objectives. Should any of the data display a bias exceeding the accuracy criteria, corrective action will be taken as described in the method, the relevant SOPs, or according to the provisions of Section 5. Peer and senior review of work products will be provided as a check on measurement accuracy.

6.3 SAMPLE QUANTITATION/REPORTING LIMITS (LIMIT OF DETECTION)

The laboratory will determine MDLs using procedures presented in Title 40 of the Code of Federal Regulations, Part 136, Appendix B, or equivalent statistical approach. To ensure that valid MDL values are determined, the laboratory shall analyze an MDL check sample by spiking an interference-free matrix with all target analytes at about two times the calculated MDL. The MDL check sample shall be taken through all the preparatory and determinative steps. A response must be verified. If any target is not detected, then the concentration will be increased and repeated until a suitable MDL concentration can be achieved. This newly established concentration will be reported. The laboratory may then demonstrate continued MDL capability by analyzing the MDL check sample each quarter instead of the prescribed annual study.

The method reporting limit (MRL) is the concentration that is reported as non-detect (<MRL). This concentration may be at the MDL in the case of risk assessment support and would be defined as sample quantitation limit (SQL) when adjusted for sample action such as dilutions and percent solids. The MRL should be less than half the project-specific action levels.

The objective of this site investigation is to determine the possible nature and extent of previously identified contaminants of concern. The applicable soil limits are displayed in Table 6-1 and the aqueous limits are displayed in Table 6-2.

TABLE 6-1
Soil Method Detection and Reporting Limits

	CAS	Adjusted Residential Soil RIII RBC (µg/kg)	RIII SSL DAF 1 (µg/kg)	STL MDL (µg/kg)	STL MRL (µg/kg)	Accuracy Lower Control Limit (%)	Accuracy Upper Control Limit (%)	Precision (%)
Metals by 6010B Trace								
Arsenic	7440-38-2	426	1.30	400	1200	80	120	20
Chromium	7440-47-3	23500	2100	120	500	80	120	20
Organochlorine Pesticides by SW8081A								
Aldrin	309-00-2	37.6	0.384	0.3	1.7	45	140	40
alpha-BHC	319-84-6	101	0.0446	0.3	1.7	60	125	40
beta-BHC	319-85-7	355	0.156	0.4	1.7	60	125	43
gamma-BHC (Lindane)	58-89-9	491	0.216	0.34	1.7	60	125	36
delta-BHC	319-86-8	--	--	0.37	1.7	55	130	34
Chlordane	57-74-9	1820	46	2.8	17	--	--	--
4,4'-DDD	72-54-8	2660	558	0.5	1.7	30	135	35
4,4'-DDE	72-55-9	1880	1760	0.35	1.7	70	125	39
4,4'-DDT	50-29-3	1880	58	0.4	1.7	45	140	42
Dieldrin	60-57-1	39.9	0.108	0.34	1.7	65	125	33
Endosulfan I	959-98-8	--	--	0.33	1.7	15	135	41
Endosulfan II	33213-65-9	--	--	0.42	1.7	35	140	27
Endosulfan sulfate	1031-07-8	--	--	0.38	1.7	60	135	34
Endrin	72-20-8	2350	272	0.34	1.7	60	135	38
Endrin aldehyde	7421-93-4	--	--	0.89	2.7	35	145	29
Endrin ketone	53494-70-5	--	--	0.7	2.7	65	135	32
Heptachlor	76-44-8	142	42.1	0.29	1.7	50	140	44
Heptachlor epoxide	1024-57-3	70.2	1.23	0.42	1.7	65	130	43
Methoxychlor	72-43-5	39100	15300	0.51	3.3	55	145	41
Toxaphene	8001-35-2	581	31.3	12	67	--	--	--
Organophosphorous Pesticides by SW8141A								
Chlorpyrifos	2921-88-2	23500	3160	4.3	33	--	--	--
Diazinon	333-41-5	7040	21.5	4.7	33	--	--	--
Dichlorvos (DDVP)	62-73-7	2200	0.0549	10	33	--	--	--
Disulfoton	298-04-4	313	3.21	4.9	33	40	115	71
Malathion	121-75-5	156000	404	4.4	33	--	--	--
Naled	300-76-5	15600	--	5.1	33	--	--	--
Parathion, ethyl	56-38-2	46900	499	4.2	33	57	136	30
Parathion, methyl	298-00-0	1960	4.27	4.8	33	55	125	30
Ronnel	299-84-3	391000	--	4.3	33	--	--	--

TABLE 6-2
Aqueous Method Detection and Reporting Limits

	CAS	Adjusted Tap Water RIII RBC (µg/L)	STL MDL (µg/L)	STL MRL (µg/L)	Accuracy Lower Control Limit (%)	Accuracy Upper Control Limit (%)	Precision (%)
Metals by 6020							
Arsenic	7440-38-2	0.0446	0.49	5	80	120	20
Chromium	7440-47-3	11.0	0.16	2	80	120	20
Organochlorine Pesticides by SW8081A							
Aldrin	309-00-2	0.00394	0.0061	0.05	25	140	33
alpha-BHC	319-84-6	0.0106	0.0062	0.05	60	130	54
beta-BHC	319-85-7	0.0372	0.0068	0.05	65	125	54
gamma-BHC (Lindane)	58-89-9	0.0515	0.0062	0.05	25	135	22
delta-BHC	319-86-8	--	0.0064	0.05	45	135	44
Chlordane	57-74-9	0.191	0.035	0.5	--	--	--
4,4'-DDD	72-54-8	0.279	0.0085	0.05	25	150	39
4,4'-DDE	72-55-9	0.197	0.0076	0.05	35	140	39
4,4'-DDT	50-29-3	0.197	0.0086	0.05	45	140	50
Dieldrin	60-57-1	0.00419	0.0067	0.05	60	130	37
Endosulfan I	959-98-8	--	0.0072	0.05	50	110	36
Endosulfan II	33213-65-9	--	0.0072	0.05	30	130	52
Endosulfan sulfate	1031-07-8	--	0.0083	0.05	55	135	40
Endrin	72-20-8	1.10	0.0074	0.05	55	135	40
Endrin aldehyde	7421-93-4	--	0.0091	0.05	55	135	54
Endrin ketone	53494-70-5	--	0.013	0.05	75	125	44
Heptachlor	76-44-8	0.0149	0.0062	0.05	40	130	32
Heptachlor epoxide	1024-57-3	0.00736	0.0065	0.05	60	130	31
Methoxychlor	72-43-5	18.3	0.01	0.1	55	150	29
Toxaphene	8001-35-2	0.0609	0.5	2	--	--	--
Organophosphorous Pesticides by SW8141A							
Chlorpyrifos	2921-88-2	--	0.12	1	--	--	--
Diazinon	333-41-5	--	0.15	1	--	--	--
Dichlorvos (DDVP)	62-73-7	3.29	0.39	1.2	--	--	--
Disulfoton	298-04-4	--	0.12	1	41	128	30
Malathion	121-75-5	--	0.12	1	--	--	--
Naled	300-76-5	--	0.18	1	--	--	--
Parathion, ethyl	56-38-2	--	0.10	1	48	134	30
Parathion, methyl	298-00-0	0.913	0.12	1	46	128	30
Ronnel	299-84-3	183	0.13	1	--	--	--

6.4 COMPLETENESS

The definition and calculation for completeness is found in Section 3.3.4.

7.0 LABORATORY OPERATIONS DOCUMENTATION

Significant amounts of historical data may be incorporated into the outcome of this work. These data inputs include records of historical activities (summarized as site background information), historical geotechnical and hydrogeologic data, and historic chemical analysis data for environmental media. The fitness for use of all such data is subject to assessment by project management and relevant technical experts. Historical chemical data in particular will be assessed to ensure precision, accuracy, representativeness, comparability, completeness, and sensitivity are consistent with the objectives of this work. Any historical data deemed by project management to be critical to the successful outcome of this project will be subject to a level of review equivalent to that described in Section 8 of this QAPP.

7.1 SAMPLE MANAGEMENT RECORDS

The records for sample management are described in Section 4 of this document.

7.2 DATA REPORTING PROCEDURES

The analytical data will be submitted in electronic format (PDF on CD) as well as in hardcopy format. Electronic data deliverables (EDDs) are required. The laboratory will present the analytical data in a CSV (comma separated values) format. The EDDs will ultimately be transmitted to USACE for input into GIS-Key software.

7.2.1 Data Package Format and Content

For the first round of sampling, a summary data reporting format consisting of analytical results and a QC summary will be provided (see Screening Data, below). For all subsequent rounds of sampling and analysis, the required analytical deliverable for definitive data types from the fixed-base laboratory must include the following at a minimum.

Definitive Data

The following forms are required for all metals analyses.

- Narrative and sample identification cross reference
- Copies of Chain of Custody documentation
- Inorganic analysis summary
- Initial and continuing calibration summary
- Calibration blank summary
- ICS summary
- Method blank summary
- Matrix spike/PDS summary
- Duplicate summary
- LCS summary

- Serial dilution summary
- Instrument raw data
- Sample preparation and run logs
- Analytical sequence summary
- Definition of IDLs, MDLs, and MRLs

An example of an acceptable QA/QC summary is presented below.

QA/QC SUMMARY

Batch ID:

Matrix: Fraction:

Related Samples:

Parameter	Passed	Failed	Note
Holding time			
Surrogates			
Matrix spike			
Spike duplicate			
Blanks			
Calibration			
Check Sample			

Narrative Notes:

7.3 DATA MANAGEMENT PROCEDURES

The generalized data flow is as follows:

> Field data are collected and recorded in bound field notebooks according to the provisions of this section and the PCDs. Sample custody and analysis requests are documented on appropriate forms and forwarded to the laboratory. Custody is accepted at the laboratory and samples are recorded in the receiving log. Sample processing is recorded in sample preparation logs and run logs. Raw data either is generated by instrumentation or recorded by the analyst in the appropriate logs. Data are further reduced according to procedures and formulae defined in relevant SOPs. Data are peer reviewed and a report is produced. The report, including any electronic forms is further reviewed for accuracy and completeness. Reports are forwarded to the data user with copies to central files

Electronic data is derived from automated data acquisition systems such as a GC. This instrument is equipped with software that performs various manipulations, identifications, and calculations of analytical data. Software calculations will be verified manually during the data validation process. Other data generated by laboratory personnel may consist of analytical results recorded by the analyst. This data will be documented in a logbook and may

subsequently be entered into one or another form of electronic files. The Field and Laboratory Managers or their designees, as a part of their periodic reviews of logbooks and deliverables, will audit transcriptions to ensure accuracy. Any errors encountered will trigger further auditing until no transcriptions errors are encountered in the audit set, up to and including 100% review.

Raw analytical data that require further reduction to produce usable analytical results will be reduced according to procedures defined in the referenced analytical method or SOP for the activity. After the data have been generated, they are subjected to a three tiered review process. This review process includes verifying the electronic identifications and calculations performed by the software and the analyst.

The first level of review is performed by the responsible technician/analyst. The technician/analyst verifies that QC acceptance criteria have been met and that instrument operating conditions were appropriate to the analysis performed. The second level of review is performed by a peer who performs a double check of the technician/analyst observations, calculations, and QC criteria. At this point, assuming any anomalies identified by the peer have been reconciled, a preliminary report is assembled. The third level of review is performed by a senior staff member, who performs the same checks on the final report. The QAO will also perform reviews of work products as part of his audits.

Data are reported in three forms, a hardcopy form, an Adobe Acrobat version of the hardcopy, and in electronic form, depending upon the data user's requirements. Screening level data (not routinely reported with the final report) include sample identification information, results for the sample analyses, and a summary of the QC data including calibrations and verifications of precision, accuracy, and representativeness where appropriate. Definitive level data reports will include all of the above with hard copies of all supporting information, including copies of instrument printouts and all log pages pertaining to the work. For purposes of this program a laboratory deliverable equivalent to a USEPA Level IV will be required of the fixed-base laboratory. Electronic deliverables are required. The laboratory will be present the analytical data in a CSV format. The EDDs will ultimately be transmitted to USACE for input into GIS-Key software.

Analytical results will include statements of sensitivity for non-detects whenever applicable. Whether delivered in "Screening" or "Definitive" data packages, all case files will contain copies of or references to all relevant raw and processed data. However, as with bound log books, these data may not be replicated in each case file.

If data manipulation or reduction is performed electronically, outside of the raw data produced by purchased instrumentation, the formulae or macros employed for these purposes will be validated by comparing the results of a sample manual calculation to the result produced electronically. This validation will be documented and maintained in central files.

Additional detail regarding data review and validation is provided in Section 2 and 8. Data transformations, to the extent that they are applicable to this work, are detailed in the referenced analytical methods and SOPs. Data analysis techniques applicable to the data will be

taken from three sources: (1) Requirements for the Preparation of Sampling and Analysis Plans, EM200-1-3, Appendix I, February 2001; (2) USEPA Region III, Innovative Approaches to Data Validation, June 1995; and, (3) Chemical Quality Assurance for HTRW Projects, EM 200-1-6, October 1997. As applies to this program, data tracking will be performed by the laboratory LIMS.

7.3.1 Laboratory Turnaround Time

The turnaround time will be the standard 28 calendar days for all laboratory deliverables. This time will start from the day of receipt at the laboratory and end on the day of receipt by the QAO.

7.3.2 Data Archival/ Retention Requirements

All records will be designated as "lifetime" or "nonpermanent" before temporary or final storage. Nonpermanent records will be retained for five years after the completion of the field work, or five years after the date the record was generated, whichever is longer. A lifetime record will be stored until authorized for destruction by either the client or legal order.

Records of either type will be catalogued before shipment to the storage facility. The storage facility will confirm that the received parcels contain all of the catalogued records and convey a receipt for the records to the originating office. The records will be made available to the originating office upon request and according to the procedures of the storage facility.

The QAO will review all records as they are received from various sources (e.g., the client, the laboratory, subcontractors, etc.) and determine whether the records are lifetime or nonpermanent. Lifetime records must meet one or more of the following criteria:

- The record may be of significant value in demonstrating capability for safe operations;
- The record may be of significant value in maintaining, reworking, repairing, replacing or modifying an item, or updating applicable remedial investigation and feasibility studies;
- The record may be of significant value in determining the cause of an accident or malfunction of an item; or,
- The record provides required baseline data for in-service inspections.

Nonpermanent records are those records that do not meet the listed criteria.

8.0 DATA ASSESSMENT PROCEDURES

Assessments of work and data quality are provided by several means. First, peer and senior review of work and work products are required by this plan at various stages. Second, individual SOPs contain detailed QC requirements, acceptance criteria, and corrective action requirements. Third, periodic, independent auditing is stipulated as a part of this plan. Fourth, formal pre-qualification of subcontractors is required by this plan.

8.1 DATA QC REVIEW

Upon completion of the data collection activities, the QAO will perform a review of the data collected and produce a report for the Project Manager addressing the following:

- Sampling design - What, if any, deviations were observed from the PCDs in terms of numbers of samples collected, locations of sample collection points, and unexpected events or observations in the field. An assessment will be provided of the impact of any such deviations on the usability or interpretation of the results.

- Sampling procedures - What, if any, deviations were observed from the PCDs in terms of the method of work applied in the collection of the samples. An assessment will be provided of the impact of any such deviations on the usability or interpretation of the results.

- Sample handling - What, if any, deviations were observed from the PCDs in terms of the handling and custody of the samples, including containers, preservation, storage, etc. This will include an assessment of any potential sample alias problems. An assessment will be provided of the impact of any such deviations on the usability or interpretation of the results.

- Analytical procedures - What, if any, deviations were observed from the PCDs in terms of the method of work applied in the analysis of the samples. An assessment will be provided of the impact of any such deviations on the usability or interpretation of the results.

- Quality control and calibration- What, if any, deviations were observed from the PCDs in terms of conformance to QC and calibration criteria. An assessment will be provided of the impact of any such deviations on the usability or interpretation of the results. This assessment will be provided in the form of data validation reports as defined in Section 8.2.

- Data reduction and processing - What, if any, deviations were observed from the PCDs in terms of data reduction and processing specifications. An assessment will be provided of the impact of any such deviations on the usability or interpretation of the results.

8.2 DATA VERIFICATION/VALIDATION

Definitive data will be validated according to protocols defined in the USEPA Region III Innovative Approaches to Data Validation, June 1995 using the review levels IM-2 and OM-3. Data flags will adhere to USEPA Region III definitions. The protocols are applied in the following order of precedence: the criteria in this QAPP, EM 200-1-3, the SW-846 method, the laboratories' SOPs, and Region III validation guidelines. A checklist based on the method/protocol is filled out by an independent reviewer. This checklist documents the checks performed and the observations of the reviewer. To the fullest extent possible the validator will work with the laboratory to resolve any anomalies encountered. The validator then applies data qualifying flags to the data summaries provided by the laboratory and compiles a report on each laboratory report consisting of a summary of the findings, copies of data summaries with data qualifying flags applied (if any), a copy of the data validation checklist, and supporting documentation.

8.3 RECONCILIATION WITH DATA QUALITY OBJECTIVES

The QAO in association with the Project Manager will provide an assessment of the conformance of data gathered in the course of these activities to objectives of the work. Because the data are not intended to be compared to fixed regulatory standards for purposes of assessing compliance, formal, numeric DQOs have not been established. Nonetheless, the data must be suitable for use in assessing the nature and extent of environmental impacts; assessing the risks associated with any such impacts; and as inputs to engineering decisions and designs. Thus data which are found during the verification and validation processes to be unsuitable for use (i.e., data impacted by unacceptable deviations from plans and protocols and data found to be qualified as unreliable during the validation process) will be clearly identified and excluded from use in downstream decision making. If, in the judgement of the Project Manager and the technical data users, insufficient data remain for purposes of the work, additional sample collection and analysis may be performed. Data description and assessment tools as described in EPA QA/G-9, Guidance for Data Quality Assessment, may be employed in the course of this reconciliation.

ATTACHMENT A
TO APPENDIX B (QAPP)

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USEPA Region III, Innovative Approaches to Data Validation, June 1995.

ATTACHMENT B
TO APPENDIX B (QAPP)

List of Abbreviations and Acronyms

LIST OF ABBREVIATIONS AND ACRONYMS

CAR	Corrective Action Report
CCB	Continuing Calibration Blanks
CCC	Continuing Calibration Check Compounds
CCV	Continuing Calibration Verification
CDQAR	Chemical Data Quality Assessment Report
CFR	Code of Federal Regulations
COPC	Compound of potential concern
COR	Contracting Office Representative
CQAR	Chemical Quality Assurance Report
CSV	Comma separated values
DERP	Defense Environmental Restoration Program
DOE	Department of Energy
DQO	Data Quality Objectives
DQI	Data Quality Indicators
EDD	Electronic data deliverable
EPA	Environmental Protection Agency
FCR	Field change request
FOL	Field Operations Leader
FSP	Field Sampling Plan
HASP	Health and Safety Plan
HTRW	Hazardous Toxic and Radiological Waste
ICB	Initial Calibration Blank
ICS	Inter-element Check Standard
ICV	Initial Calibration Verification
IDW	Investigation Derived Waste
ITRT	Independent Technical Review Team
IRM	Interim Reference Material
LCS	Laboratory Control Sample

LIST OF ABBREVIATIONS AND ACRONYMS (cont'd)

LIMS	Laboratory Information Management System
LQAC	Laboratory Quality Assurance Coordinator
MB	Method Blank
MRD	Missouri River Division
MDL	Method Detection Limit
MQL	Method Quantitation Limit
MRL	Method Reporting Limit
MSA	Method of Standard Additions
MS	Matrix Spike
MSD	Matrix Spike Duplicate
MSDS	Material safety data sheet
NIST	National Institute of Standards and Technology
OSHA	Occupational Safety and Health Administration
PA	Preliminary Assessment
PCD	Project Controlling Documents
PDS	Post Digestion Spike
PQL	Practical quantitation limit
QA	Quality Assurance
QAO	Quality Assurance Officer
QAPP	Quality Assurance Project Plan
QC	Quality Control
RI	Remedial Investigation
RPD	Relative Percent Difference
RSD	Relative Standard Deviation
SAP	Sampling and Analysis Plan
SARM	Standard Analytical Reference Material
SD	Serial Dilution

LIST OF ABBREVIATIONS AND ACRONYMS (cont'd)

SI	Site Inspection
SMF	Sporadic Marginal Failure
SOP	Standard operating procedure
SPCC	System Performance Check Compounds
SQL	Sample Quantitation Limit
SRM	Standard reference material
SSO	Site Safety Officer
SVOC	Semivolatile organic compound
TAL	Target Analyte List
TCL	Target Compound List
TCLP	Toxicity characteristic leaching procedure
TPP	Technical Project Planning
URS	URS Operating Services, Inc.
USACE	U.S. Army Corps of Engineers
USEPA	U.S. Environmental Protection Agency

ATTACHMENT C
TO APPENDIX B (QAPP)

STL
Standard Operating Procedures

Attachment C Contents

- **ICP EPA Methods 6020 and 200.8**
- **Acid Digestion of Aqueous Samples by SW846 and MCAWW 200 Series Methods**
- **GC Analysis Based on Methods 8000B, 8021B, 8081A, 8082, 8151A, 8310, 8141A, 8015B, and 614**
- **Acid Digestion of Soils, SW846 Method 3050B**
- **ICP-AES for Trace Element Analyses, SW-846 Method 6010B and EPA Method 200.7**
- **Extraction and Cleanup of Organic Compounds from Waters and Soils, Based on SW-846 Series 3500, 3600, 8151A, and 600 methods**

STL North Canton
STANDARD OPERATING PROCEDURE

TITLE: **INDUCTIVELY COUPLED PLASMA-MASS SPECTROMETRY, EPA METHODS 6020 AND 200.8**

(SUPERSEDES: 4.1 Dated 10/01/03)

Prepared by:		1/21/04 Date
Reviewed by:	Technology Specialist	1/21/04 Date
Approved by:	Quality Assurance Manager	1/21/04 Date
Approved by:	Environmental Health and Safety Coordinator	1/28/04 Date
Approved by:	Laboratory Director	1/29/04 Date

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1. SCOPE AND APPLICATION

1.1. This procedure describes multi-elemental analysis by inductively coupled plasma-mass spectrometry (ICP-MS) based on SW-846 protocol as described in EPA Method 6020 and 200.8. The source method lists fifteen elements approved for analysis by ICP/MS (Al, Sb, As, Ba, Be, Cd, Cr, Co, Cu, Pb, Mn, Ni, Ag, Tl, and Zn). Additional elements may be included provided that the method performance criteria presented in Section 9 is met. However, project approval may be required from the controlling agencies for compliance testing beyond the fifteen elements included in the promulgated method.

1.2. This procedure also describes the requirements for performing analysis of ground waters, surface waters and drinking water.

1.3. The procedure is applicable to the analysis of waters, soils, and wastes. No digestion is required prior to analysis for dissolved elements in water samples, but the samples must be filtered and preserved prior to analysis. Preliminary acid digestion is required for groundwater, aqueous samples, sludges, sediments, and other solid wastes for which total (acid-leachable) elements are requested. See SOP # CORP-IP-0002NC and SOP #CORP-IP-0003NC for preparation details.

1.4. The associated QuantIMs method codes are MH (6020) and QV (200.8)**.**

1.5. This document accurately reflects current laboratory standard operating procedures (SOP) as of the date above. All facility SOPs are maintained and updated as necessary.

2. SUMMARY OF METHOD

2.1. Aqueous samples, digestates, or leachates are nebulized into a spray chamber where a stream of argon carries the sample aerosol through the quartz torch and injects it into an R.F. plasma. There the sample is decomposed and desolvated. The ions produced are entrained in the plasma gas and by means of a water-cooled, differentially pumped interface, introduced into a high-vacuum chamber that houses a quadrapole mass spectrometer capable of providing a resolution better than or equal to 0.9 AMU peak width at 10% of the peak height. For analysis by methods 200.8 the resolution requirement is 1.0 amu at 5% peak height. The ions are sorted according to their mass-to-charge ratio and measured with a channel electron multiplier. Interference must be assessed and valid corrections applied, or the data flagged to indicate problems. Interference correction must include compensation for background ions contributed by the plasma gas, reagents and the constituents of the sample matrix. Recommended elemental equations which correct for many of these interferences are listed in Table I. Use of the internal standard technique is required to compensate for suppressions and enhancements caused by sample matrices.

3. DEFINITIONS

3.1. Refer to the glossary in the Laboratory Quality Manual (LQM), latest version.

3.2. *Dissolved Metals* - Those elements which pass through a 0.45 µm membrane filter (sample is acidified after filtration).

3.3. *Suspended Metals* - Those elements which are retained by a 0.45 µm membrane filter.

3.4. *Total Metals* - The concentration determined on an unfiltered sample following vigorous acid digestion.

3.5. *Total Recoverable Metals* - The concentration determined on an unfiltered sample following treatment with hot, dilute mineral acids.

3.6. *Instrument Detection Limit (IDL)* - See Section 9.1.1.

3.7. *Sensitivity* - The slope of the analytical curve (i.e. the functional relationship between raw instrument signal and the concentration).

3.8. *Tuning Solution* - This is a multi-element solution containing analytes which are representative of the entire mass range capable of being scanned by the instrument. It is used to optimize the sensitivity of the instrument and to verify the mass resolution meets method criteria.

3.9. *Initial Calibration Verification/Quality Control Standard (ICV/QCS)* - A multi-element standard of known concentrations prepared to verify instrument calibration. This solution must be an independent standard prepared near the mid-point of the calibration curve, and at a concentration other than that used for instrument calibration.

3.10. *Continuing Calibration Verification (CCV).* - A multi-element standard of known concentrations prepared to monitor and verify the instrument daily continuing performance.

3.11. *Interference Check Standard (ICS)* - A solution containing both interfering and analyte elements of know concentration that is used to verify background and interelement correction factors.

3.12. *Laboratory Control Sample / Laboratory Fortified Blank (LCS/LFB)* - A multi-element standard of known concentrations which is carried through the entire sample preparation and analysis procedure. This solution is used to verify the accuracy of the sample preparation.

3.13. *Reagent Blank* - High purity (> 18 megohm-cm) water carried through the entire digestion process.

3.14. *Calibration Blank* - High purity (> 18 megohm- cm) water acidified with the same acid concentrations present in the standards and samples Also referred to as the Initial Calibration Blank (ICB) and Continuing Calibration Blank (CCB).

3.15. *Method Detection Limit (MDL)*. See section 9.1.3

4. INTERFERENCES

4.1. Isobaric Interferences - Isobaric interferences in the ICPMS are caused by isotopes of different elements forming ions with the same nominal mass-to-charge ratio (m/z). Most interferences of this type are corrected for by the instrument software.

4.2. Isobaric Molecular and Doubly Charged Ion Interferences - Isobaric molecular interferences are caused by ions consisting of more than one atom or charge. Table II lists isobaric interferences which might possibly affect required analytes. When these interferences cannot be avoided by the use of another isotope with sufficient natural abundance, corrections must be applied and the data flagged to indicate the presence of interferences.

4.3. Physical Interferences - Physical interferences are associated with the transport and nebulization process. Internal standards are used to compensate for these types of interferences.

4.3.1. Internal standards should be added at a level to give approximately 100,000 – 1,000,000 counts of raw signal intensity. The mass of the internal standard should ideally be within 20 amu of the mass of the measured analyte.

4.3.2. Matrix effects will be monitored by comparing the internal standard intensity in the sample to the internal standard intensity of the calibration blank. When performing method 6020 the internal standard intensities must be between 30% and 120% of the intensities in the calibration blank. If they fall outside this window, a five fold dilution (1:4) is performed on the sample to correct for matrix effects and the sample reanalyzed. When performing method 200.8 the internal standards must be between 60% and 125% of the calibration blank. If they are outside this window the calibration blank is reanalyzed to verify internal standard intensities. If the intensities are within limits the sample is diluted by a factor of 2 (1:1) and reanalyzed.

4.3.3. Memory effects are dependent on the relative concentration differences between samples and/or standards which are analyzed sequentially. The rinse period between samples must be long enough to eliminate significant memory interference.

4.3.4. Method interferences may be caused by contaminants in solvents, reagents, glassware, and other processing apparatus that lead to discrete artifacts. All of these materials must be routinely demonstrated to be free from interferences under conditions of the analysis by running laboratory method blanks as described in the Quality Control section. Specific selection of reagents may be required to avoid introduction of contaminants.

5. SAFETY

5.1. Employees must abide by the policies and procedures in the Corporate Safety Manual, Radiation Safety Manual and this document.

5.2. Eye protection that protects against splash, laboratory coat, and appropriate gloves must be worn while samples, standards, solvents, and reagents are being handled. Disposable gloves that have been contaminated will be removed and discarded; other gloves will be cleaned immediately.

5.3. The following is a list of the materials used in this method, which have a serious or significant hazard rating. **NOTE: This list does not include all materials used in the method. The table contains a summary of the primary hazards listed in the MSDS for each of the materials listed in the table.** A complete list of materials used in the method can be found in the reagents and materials section. Employees must review the information in the MSDS for each material before using it for the first time or when there are major changes to the MSDS.

Material (1)	Hazards	Exposure Limit (2)	Signs and symptoms of exposure
Hydrochloric Acid	Corrosive Poison	5 ppm-Ceiling	Inhalation of vapors can cause coughing, choking, inflammation of the nose, throat, and upper respiratory tract, and in severe cases, pulmonary edema, circulatory failure, and death. Can cause redness, pain, and severe skin burns. Vapors are irritating and may cause damage to the eyes. Contact may cause severe burns and permanent eye damage.
Nitric Acid	Corrosive Oxidizer Poison	2 ppm-TWA 4 ppm-STEL	Nitric acid is extremely hazardous; it is corrosive, reactive, an oxidizer, and a poison. Inhalation of vapors can cause breathing difficulties and lead to pneumonia and pulmonary edema, which may be fatal. Other symptoms may include coughing, choking, and irritation of the nose, throat, and respiratory tract. Can cause redness, pain, and severe skin burns. Concentrated solutions cause deep ulcers and stain skin a yellow or yellow-brown color. Vapors are irritating and may cause damage to the eyes. Contact may cause severe burns and permanent eye damage.
1 – Always add acid to water to prevent violent reactions.			
2 – Exposure limit refers to the OSHA regulatory exposure limit.			

5.4. The **RF Generator** produces strong radio frequency waves, most of which are unshielded. People with pacemakers should not go near the instrument while in operation.

5.5. Exposure to chemicals must be maintained **as low as reasonably achievable**, therefore, unless they are known to be non-hazardous, all samples must be opened, transferred and prepared in a fume hood, or under other means of mechanical ventilation. Solvent and waste containers will be kept closed unless transfers are being made.

5.6. It is recommended that neat standards be purchased only as a last resort. The preparation of standards from neat materials and reagents {as well as glassware cleaning procedures that involved solvents such as methylene chloride} should be conducted in a fume hood with the sash closed as far as the operations will permit.

5.7. Standards in solution may be diluted in the open laboratory when syringes and the like are utilized.

5.8. The ICP plasma emits strong UV light and is harmful to vision. All analysts must avoid looking directly at the plasma.

5.9. All work must be stopped in the event of a known or potential compromise to the health and safety of a STL associate. The situation must be reported **immediately** to a laboratory supervisor.

6. EQUIPMENT AND SUPPLIES

6.1. Argon gas: High purity grade (99.99%).

6.2. Inductively Coupled Plasma Mass Spectrometer capable of providing resolution, less than or equal to 0.9 AMU at 10% peak height from 6-253 AMU and 1.0AMU at 5% peak height from 6-253 AMU with a data system that allows corrections for isobaric interferences and the application of the internal standard technique.

6.3. A four channel peristaltic pump.

6.4. Appropriate water cooling device.

6.5. Calibrated automatic pipettes or Class A glass volumetric pipettes.

6.6. Autosampler with autosampler tubes.

7. REAGENTS AND STANDARDS

7.1. Calibration standards are purchased as custom STL multielement mixes or as single element solutions. All standards must be stored in FEP fluorocarbon or previously unused polyethylene or polypropylene bottles. Intermediate standard solutions must be replaced prior to the expiration date provided by the manufacturer. If no expiration date is provided, the intermediate solutions may be used for up to one year and must be replaced sooner if verification from an independent source indicates a problem. See Table XI.

7.2. Check Calibration Standard (ICV)

A quality control standard similar to the calibration standards and prepared in the same acid matrix. This solution must be made at a concentration near the midpoint of the calibration curve. This standard is composed of analytes from a different source from those used in the calibration of the instrument. See Table XI.

7.3. The tuning solution is purchased as custom STL multielement mixes or as single element solutions. All standards must be stored in FEP fluorocarbon or previously unused polyethylene or polypropylene bottles. The solution must be replaced prior to the expiration date provided by the manufacturer. If no expiration date is provided, the intermediate solutions may be used for up to one year.

7.4. The use of hydrochloric and sulfuric acids should be minimized due to higher incidence of molecular-ion interferences with the presence of these acids. Excessive amounts of nitric acid can also lead to molecular interferences.

7.5. Reagent water:

ASTM Type I or equivalent for the elements of interest, generated using an ion-exchange water polishing system capable of achieving 18.0 megohm-cm.

7.6. Rinse Solution: Carefully dilute 200 mL of concentrated HNO_3 and 40mL of concentrated HCl to 4.0 L with reagent water.

8. SAMPLE COLLECTION, PRESERVATION AND STORAGE

8.1. Aqueous samples are preserved with nitric acid to a pH of 2, and may be stored in plastic or glass. Preservation must be verified prior to analysis.

8.2. Soil samples do not require preservation, but must be stored at 4° ± 2°C until the time of preparation.

8.3. The analytical holding times for metals are six months from the time of collection.

8.4. Solid and aqueous samples must be digested prior to analysis by the appropriate method.

9. QUALITY CONTROL

9.1. Initial Demonstration of Capability

Table X provides a summary of quality control requirements including type, frequency, acceptance criteria and corrective action. Prior to analysis of any analyte the following requirements must be met.

9.1.1. Instrument Detection Limit (IDL) - IDLs can be determined by calculating the average of the standard deviations of the three runs on three non-consecutive days from the analysis of a reagent blank solution with seven consecutive measurements per day. Each measurement must be performed as a separate analytical sample. The IDL should be performed every three months.

9.1.2. Linear Calibration Ranges - Linear calibration ranges are primarily detector limited. The linear range must be determined at instrument setup, and the upper limit must be verified annually or whenever a change in instrument hardware or operating conditions, in the judgement of the analyst, may lower expected ranges. Standards used to determine or verify linear ranges must be analyzed during a routine analytical run. The linear range is the concentration above which sample results cannot be reported.

9.1.2.1. For initial determination of the upper limit of the linear range, determine the signal responses from three different concentration standards across the estimated range. One standard must be at the upper limit of the estimated range. Results must recover within 10% of the expected value for the three standards. The Linear Range is then set at the concentration of the high standard.

9.1.2.2. For verification of the upper limit of the linear range, the high standard must recover within 10% of its expected value.

9.1.3. Method Detection Limit (MDL) - The laboratory shall determine a method detection limit for all analytes of interest initially and annually thereafter. The MDL study is performed and calculated according to STL SOP S-Q-003, which is based on 40CFR Part 136 Appendix B.

9.2. Batch Definition

9.2.1. A batch is a group of no greater than 20 samples excluding QC samples (LCS, Method Blank, MS, MSD) which are processed similarly, with respect to the procedure. All sample setups must be initiated within a 24 hour period from the initial preparation or extraction and without interruption of the process. All samples within the batch must be treated with the same lots of reagents and the same processes.

9.3. Method Blank

9.3.1. One method blank (MB) must be processed with each preparation batch. The method blank consists of reagent water containing all reagents specific to the method that is carried through the entire analytical procedure, including preparation and analysis. The method blank is used to identify any system and process interferences or contamination of the analytical system that may lead to the reporting of elevated analyte concentrations or false positive data. The method blank should not contain any analyte of interest at or above the reporting limit (exception: common laboratory contaminants, see below) or at or above 5% of the measured concentration of that analyte in associated samples, whichever is higher (sample result must be a minimum of 20x higher than the blank contamination level).

- If the analyte is a common laboratory contaminant (copper, iron, lead, calcium, magnesium, potassium, sodium or zinc) the data may be reported with qualifiers if the concentration of the analyte in the method blank is less than two times the RL. Barium, Chromium and Manganese may also be considered common laboratory contaminants at ICPMS reporting limits. **Such action must be addressed in the project narrative.**

- Repreparation and reanalysis of all samples associated with an unacceptable method blank is required when reportable concentrations are determined in the samples (see exception noted above).

- If there is no analyte greater than the RL in the samples associated with an unacceptable method blank, the data may be reported with qualifiers. **Such action must be addressed in the project narrative.**

- If the above criteria are not met and reanalysis is not possible, then the sample data must be qualified. **This anomaly must be addressed in the project narrative.**

9.3.2. For dissolved metals samples which have not been digested, a CCB result is reported as the method blank. The CCB run immediately prior to the start of the

dissolved sample analyses must be used for this purpose. No more than 20 samples can be associated with one CCB

9.4. Laboratory Control Sample (LCS)

9.4.1. One LCS from an independent source must be processed with each preparation batch. The LCS must be carried through the entire analytical procedure. The LCS is used to monitor the accuracy of the analytical process. On-going monitoring of the LCS results provides evidence that the laboratory is performing the method within acceptable accuracy and precision guidelines. The historical limits for the LCS for each analyte are in the LIMS system. Initial limits shall be set at 80-120% for method 6020 and 85-115% for method 200.8. If the LCS exceeds these limits for any analyte, that analyte is judged to be out of control and must be corrected before the analysis can be reported

9.4.2. Corrective Action for LCS

9.4.2.1. If any analyte is outside established control limits the system is out of control and corrective action must occur.

9.4.2.2. The only exception is that if the LCS recoveries are biased high and the associated sample is ND for the parameter(s) of interest, the batch is acceptable. **This must be addressed in the project narrative.**

9.4.2.3. Corrective action will be repreparation and reanalysis of the batch unless the client agrees that other corrective action is acceptable.

9.5. Matrix Spike/Matrix Spike Duplicate (MS/MSD)

9.5.1. One MS/MSD pair must be processed for each batch. A matrix spike (MS) is a field sample to which known concentrations of target analytes have been added. A matrix spike duplicate (MSD) is a second aliquot of the same sample (spiked identically as the MS) prepared and analyzed along with the sample and matrix spike. Some client specific data quality objectives (DQO's) may require the use of sample duplicates in place of or in addition to MS/MSD's. The MS/MSD results are used to determine the effect of a matrix on the precision and accuracy of the analytical process. Due to the potential variability of the matrix of each sample, these results may have immediate bearing only on the specific sample spiked. Samples identified as field blanks cannot be used for MS/MSD analysis. The historical spike recovery acceptance limits for each analyte are in the LIMS system. Initial limits shall be 70-130% for methods 6020 and 200.8. and the spike concentration must be the same level as the LFB. If they are not in control and all

other quality control criteria have been met then a matrix interference is suspected.

9.5.2. Corrective action for MS/MSDs

9.5.2.1. If the analyte recovery or RPD falls outside the acceptance range, the recovery of that analyte must be in control for the LCS. If the LCS recovery is within limits, then the laboratory operation is in control and the results may be accepted. If the recovery of the LCS is outside limits, corrective action must be taken. Corrective action will include repreparation and reanalysis of the batch.

9.5.2.2. If the native analyte concentration in the MS/MSD exceeds 4x the spike level for that analyte, the recovery data is reported as NC (not calculated).

9.5.2.3. If an MS/MSD is not possible due to limited sample volume then a laboratory control sample duplicate (LCSD) should be analyzed. The RPD of the LCS and LCSD must be compared to the laboratory limits.

9.5.2.4. If client program requirements specify to confirm matrix interference's, repreparation and reanalysis of the MS/MSD may be necessary.

9.6. Sample Duplicate

9.6.1. A sample duplicate (DU) is a second aliquot of an environmental sample, taken from the same sample container when possible, that is processed with the first aliquot of that sample. That is, sample duplicates are processed as independent samples within the same QC batch. The sample and DU results are compared to determine the effect of the sample matrix on the precision of the analytical process. As with the MS/MSD results, the sample/DU precision results are not necessarily representative of the precision for other samples in the batch.

9.6.2. Sample duplicates may be performed in lieu of or in addition to MSD's.

9.7. Control Limits

9.7.1. Control limits are established by the laboratory as described in SOP, NC-QA-0018.

9.7.2. Laboratory control limits are internally generated and updated periodically unless method specified. Control limits are listed in the Laboratory Quality Manual

(LQM) and the latest version is easily accessible via the LIMs (QC Browser program).

9.8. Method Detection Limits (MDLs) and MDL Checks

9.8.1. MDLs and MDL Checks are established by the laboratory as described in SOP, NC-QA-0021.

9.8.2. MDLs are listed in the Laboratory Quality Manual (LQM) and the latest version is easily accessible via the LIMs (QC Browser program).

9.9. ICV/CCV/QCS - Calibration accuracy is verified at the beginning of each analytical run by analyzing a second-source initial calibration verification (ICV) standard. A continuing calibration verification (CCV) standard is analyzed at a 10% frequency throughout the run. The ICV must be within 10% of the expected value, or the analysis is terminated. The CCV must be within 10% of the expected value for method 6020 or 15% of the expected value for method 200.8. Sample results may only be reported when bracketed by valid CCV's.

9.10. RL Verification Standard –An independent standard is analyzed after the ICV to monitor the lab's ability to produce reliable results at RL-level concentrations. There is no set acceptance criteria established for this standard, but generally results should be within 50% of the expected value.

9.11. ICB/CCB/CB - The initial calibration blank must be analyzed immediately following the ICV. The continuing calibration blank must be analyzed at a frequency of 10% throughout the remainder of the analytical run. The ICB/CCB must fall within +/- the reporting limit from zero.

9.12. Interference Check Solutions (ICSA/ICSAB) ***method 6020 only***- The interference check solution is prepared with known concentrations of interfering elements so a determination may be made as to the magnitude of the interference on analytes of interest as well as a test of any software corrections. The required elements and their concentrations are listed in Table V. The interference check solutions must be analyzed at the beginning of every analytical run and every 12 hours thereafter. The results of solution "A" and solution "AB" should be monitored for possible interferences.

9.12.1. Control limits of spiked analytes in the ICSA/ICSAB solution are +/- 50% of true value. Some projects may require control limits of +/- 20% of true value. Control limits of non-spiked analytes are +/- 2x the reporting limit or less than 1 ug/L.

Note: It may not be possible to obtain absolutely clean ICSA/ICSAB standards.

If contamination can be confirmed by another method (ICP/GFAA), acceptance criteria will be applied at that level and the data accepted.

9.13. Internal Standards:

The intensities of all internal standards must be monitored throughout the run. The internal standard in the samples must be between 30% and 120% of the intensity of the calibration blank, for Method 6020, and between 60% and 125% for Method 200.8. If the sample falls outside of this criteria, perform the following procedures. First, evaluate nearby CCV's and CCB's. If sample internal standard recoveries appear to be related to instrument drift, then rerun affected samples. If sample internal standard recoveries appear to be primarily sample related, then perform appropriate dilutions until the internal standard recoveries are within the method criteria. In no case, may Method 6020 sample results be reported with internal standard recoveries greater than 40% higher than recoveries in surrounding CCV's/CCB's. Alternately, the run may be reprocessed with an alternative internal standard that is not in the samples and at an appropriate mass for the masses being reported.

9.14. Serial Dilution ***method 6020 only*** - One serial five-fold dilution should be analyzed per batch for each matrix. If the analyte concentration is within linear range of the instrument and sufficiently high (generally, a factor of 100 times above the reporting limit), the serial dilution must agree within 10% of the original analysis. If not, an interference effect must be suspected, the result is flagged and included in the final report narrative. Samples identified as blanks cannot be used for serial dilution.

9.15. Post-Digestion Spike Addition (PDS) ***method 6020 only*** - If the serial dilution fails to meet the acceptance criteria, a PDS must be performed as follows. An analytical spike added to a portion of a prepared sample, or its dilution, should be recovered within 75 - 125% of the known value. If the PDS fails to meet this criterion, matrix interference should be suspected.

9.16. General Corrective Action Requirements - The general requirements for evaluation of QC results and corrective action for failures is described in STL Policy # QA-003

9.17. Nonconformance and Corrective Action

9.17.1. Any deviations from QC procedures must be documented as a nonconformance, with applicable cause and corrective action approved by the facility QA Manager.

10. CALIBRATION AND STANDARDIZATION

10.1. Instrument Start Up

Set up the instrument according to manufacturers operating instructions. Allow the instrument to become thermally stable for at least 30 minutes before tuning.

10.2. Instrument Tuning / Mass Calibration / Daily Performance

10.2.1. Daily Performance – Refer to Appendix A for ICPM/MS Instrument Instructions. Instrument manuals are available as needed. Verify instrument performance daily with a solution containing elements representing all of the mass regions of interest. The relative standard deviations must be less than 5% after running the tuning solution a minimum of 4 times. For method 200.8, the tuning solution must be analyzed 5 times with a relative standard deviation less than 5%.

10.2.2. Check mass calibration and resolution daily.

10.2.2.1. Mass Calibration Check – The mass calibration results must be within 0.1 amu from the true value. If this criterion is not met, the mass calibration must be adjusted before running samples.

10.2.2.2. Mass Resolution Check - The resolution must be verified to be less than 0.9 amu full width at 10% peak height. Due to a limitation of the instrument software, the resolution requirement for method 200.8 of 1.0 amu full width at 5% peak height cannot be verified automatically. If the mass resolution requirement of 0.9AMU at 10% peak height is met the 200.8 requirement is also satisfied.

10.3. Calibrate the instrument for the analytes of interest according to manufacturer's instructions. Routine calibration and calibration verification levels are shown in Table XI. The calibration should include a blank and a three standards. For a linear, multi-point calibration curve, the correlation coefficient must be >/= 0.995. Report the average of at least two integrations for both calibration and sample analysis. A calibration must be performed daily and each time the instrument is set up. Instrument run may be continued over periods exceeding 24 hours as long as calibration verification, interference check, and internal standard QC criteria are met.

11. PROCEDURE

11.1. One time procedural variations are allowed only if deemed necessary in the professional judgment of supervision to accommodate variation in sample matrix, radioactivity, chemistry, sample size, or other parameters. Any variation in procedure shall be completely documented using a Nonconformance Memo and is approved by a Technical Specialist and QA Manager. If contractually required, the client shall be notified. The Nonconformance Memo shall be filed in the project file.

11.2. Any unauthorized deviations from this procedure must also be documented as a nonconformance, with a cause and corrective action described.

11.3. Sample Preparation

11.3.1. Preliminary acid digestion is required for groundwater, aqueous samples, sludges, sediments, and other solid wastes for which total (acid-leachable) elements are requested. See SOP # CORP-IP-0002NC and SOP #CORP-IP-0003NC for preparation details.

11.4. Sample Analysis

11.4.1. Flush the system with the rinse blank for at least 30 seconds between samples and standards during the analytical run.

11.4.2. Masses which would affect the data quality must be monitored during the analytical run to determine the potential effects of matrix on a given element.

11.4.3. Dilute and reanalyze samples that are more concentrated than the linear range for an analyte or specific isotope of interest. No analyte may be reported from an analysis of a diluted sample in which the analyte concentration is less than 5 times the IDL (the sample should be diluted to the approximate midrange of the analytical curve), unless the dilution is for internal standard recoveries.

11.4.4. The analytical run sequence should be performed as follows to meet all quality control criteria:

Warm-up

Verify instrument performance

Calibration blank

Calibration standards

ICV

ICB

RL verification standard

ICSA (6020 Only)

ICSAB (6020 Only)

CCV

CCB

10 Samples

CCV

CCB

11.5. Analytical Documentation

11.5.1. Record all analytical information in the analytical logbook/logsheet which may be in an electronic format, including the analytical data from standards, blanks, LCSs, MS/MSDs, and any corrective actions or modifications to the method.

11.5.2. All standards are logged into a department standard logbook. All standards are assigned an unique number for identification. Logbooks are reviewed by the supervisor or designee.

11.5.3. Documentation such as all associated instrument printouts (final runs, screens, reruns, QC samples, etc.) and daily calibration data corresponding to all final runs is available for each data file.

11.5.4. Sample results and associated QC are entered into the LIMs after final technical review.

12. DATA ANALYSIS AND CALCULATIONS

12.1. ICV percent recoveries are calculated according to the equation:

$$\%R = \mathbf{100\ x} \left(\frac{\mathbf{Found\ (ICV)}}{\mathbf{True\ (ICV)}} \right)$$

12.2. CCV percent recoveries are calculated according to the equation:

$$\%R = \mathbf{100\ x} \left(\frac{\mathbf{Found\ (CCV)}}{\mathbf{True\ (CCV)}} \right)$$

12.3. Matrix Spike Recoveries are calculated according to the following equation:

$$\%R = \mathbf{100\ x} \left(\frac{\mathbf{SSR\ -\ SR}}{\mathbf{SA}} \right)$$

Where:
SSR = Spike Sample Result
SR = Sample Result
SA = Spike Added

Note: When sample concentration is less than the method detection limit, use SR = 0 for purposes of calculating % Recovery.

12.4. The relative percent difference (RPD) of sample duplicates are calculated according to the following equation:

$$RPD = \mathbf{100\ x} \left[\frac{\mathbf{(DU1\ -\ DU2)}}{\mathbf{(DU1\ +\ DU2)\ /\ 2}} \right]$$

Where:
DU1 = Sample result
DU2 = Sample duplicate result

12.5. The final concentration for an aqueous sample is calculated as follows:

$$\text{Result (ug/L)} = \frac{\mathbf{(C \times V1 \times D)}}{\mathbf{V2}}$$

Where:
C = Concentration from instrument readout, ppb
D = Instrument dilution factor
V1 = Final volume in liters after sample preparation
V2 = Initial volume of sample digested in liters

12.6. The concentration determined in digested solid samples when reported on a wet weight basis is as follows:

$$\text{Result (ug/kg)} = \frac{\mathbf{(C \times V \times D)}}{\mathbf{W}}$$

Where:
C = Concentration from instrument readout, ppb
D = Instrument dilution factor
V = Final volume in liters after sample preparation
W = Weight, in g, of wet sample digested

12.7. Sample results should be reported according to the following significant figure rules:

12.7.1. All uncorrected values less than the detection limit are reported as "less than" the detection limit.

12.7.2. Positive results for target analytes are reported to three significant figures if the method is used without dilution.

12.8. Positive results obtained after dilution and results for non-certified analytes are reported to two significant figures

13. METHOD PERFORMANCE

13.1. Each laboratory must have initial demonstration of performance data on file and corresponding method detection limit files.

13.2. Refer to Table I for the list of analytes that may be analyzed using this SOP for methods 6020 and 200.8. Additional analytes may be analyzed if all method required QC is acceptable.

13.3. Method performance is determined by the analysis of matrix spike and matrix spike duplicate samples as well as method blanks and laboratory control samples. The matrix spike recovery should fall within historical laboratory control limits and the matrix spike duplicates should compare within 20% RPD. Method blanks must meet the criteria specified in Section 9.3. The laboratory control samples should recover within 20% of the true value until in house control limits are established.

13.4. Training Qualifications:

13.4.1. The group/team leader has the responsibility to ensure that this procedure is performed by an associate who has been properly trained in its use and has the required experience.

14. POLLUTION PREVENTION

14.1. This method does not contain any specific modifications that serve to minimize or prevent pollution.

15. WASTE MANAGEMENT

15.1. All waste will be disposed of in accordance with Federal, State and Local regulations. Where reasonably feasible, technological changes have been implemented to minimize the potential for pollution of the environment. Employees will abide by this method and the policies in section 13 of the Corporate Safety Manual for “Waste Management and Pollution Prevention.”

15.2. Solid materials (gloves, soiled paper products, etc.) are placed in the solid debris container. Do not put liquids in the solid waste container.

15.3. Laboratory personnel assigned to perform hazardous waste disposal procedures must have a working knowledge of the established procedures and practices of STL. They must have training on the hazardous waste disposal practices upon initial assignment to these tasks, followed by an annual refresher training.

15.4. Waste Streams Produced by the Method

15.4.1. Acid waste consisting of sample and rinse solution generated by this method.

15.4.1.1. Aqueous waste can be poured down the drain if the pH is between 4 and 10. Any sample waste generated that is not in this pH range must be collected and disposed of in the acid waste drum located in the metals lab.

16. REFERENCES

16.1. References

16.1.1. Test Methods For Evaluating Solid Waste, EPA SW-846, 3rd Edition, Final Update II, Method 6020: "Inductively Coupled Argon Plasma - Mass Spectrometry", Revision 0, September 1994.

16.1.2. Environmental Monitoring Systems Laboratory, EPA Method 200.8, "Determination of Trace Elements in Waters and Wastes by Inductively Coupled Plasma - Mass Spectrometry", Revision 5.4, EMMC Version

16.1.3. Corporate Quality Management Plan (QMP), current version.

16.1.4. STL Laboratory Quality Manual (LQM), current version.

16.2. Associated SOPs and Policies, latest version

16.2.1. QA Policy, QA-003

16.2.2. CORP-IP-0002NC, Acid Digestion of Soils, SW846 Method 3050B, latest version.

16.2.3. CORP-IP-0003NC, Acid Digestion of Aqueous Samples by SW846 and MCAWW 200 Series Methods

16.2.4. Glassware Washing, NC-QA-0014

16.2.5. Statistical Evaluation of Data and Development of Control Charts, NC-QA-0018

16.2.6. Method Detection Limits and Instrument Detection Limits, NC-QA-0021

16.2.7. Navy/Army SOP, NC-QA-0016

17. MISCELLANEOUS (TABLES, APPENDICES, ETC...)

17.1. Reporting limits

17.1.1. Refer to Table XII for associated reporting limits

17.1.2. If samples require dilution or smaller volumes than specified in this method, the RL will be elevated.

17.2. Method deviations

17.2.1. Deviations from method 6020

17.2.1.1. Commercially available standards are purchased and verified at the laboratory rather than being prepared from the solid material. These verification records are kept in the laboratory.

17.2.1.2. The results of the calibration blank as well as all other blanks must be less than the reporting limit, not 3 times the instrument IDL.

17.2.1.3. Milli-Q or Nanopure water is substituted when reagent water is called for. This water is tested to be free of contaminants by conductivity (18megOhm) and by the analysis of blanks.

17.2.1.4. Internal standard recoveries may be less than 80% in CCV's and CCB's as long as QC criteria are met. Sample internal standard recoveries may never be greater than 40% higher than recoveries in associated CCV's/CCB's.

17.2.2. Deviations from method 200.8

17.2.2.1. Commercially available standards are purchased and verified at the laboratory rather than being prepared from the solid material. These verification records are kept in the laboratory.

17.2.2.2. The results of the calibration blank as well as all other blanks must be less than the reporting limit, not 3 times the instrument IDL.

17.2.2.3. Milli-Q or Nanopure water is substituted when reagent water is called for. This water is tested to be free of contaminants by conductivity (18 megOhm) and by the analysis of blanks.

17.2.2.4. Resolution criteria of the mass calibration is met if the resolution criteria for method 6020 is satisfied.

17.2.2.5.The concentration of most analytes in the LCS is 100 µg/L. This is made from a commercially available stock solution and has all analytes at the same level. Verification records for this solution are kept in the laboratory.

17.2.2.6. Results are reported up to the verified linear range, not up to only 90% of the linear range.

TABLE I: Recommended Elemental Interference Equations

Element	Isobaric Correction	Mathematical Equation
Al	none	(1.0000)(27M)
Sb	none	(1.0000)(121M)
As	ArCl, Se	(1.0000)(75M) - (3.1278)(77M) + (1.0177)(78M)
Ba	none	(1.0000)(135M)
Be	none	(1.0000)(9M)
Cd	MoO, Sn	(1.0000)(114M) - (0.0268)(118M) - (1.0000)(135M)
Ca	none	(1.0000)(44M)
Cr	none	(1.0000)(52M)
Co	none	(1.0000)(59M)
Cu	none	(1.0000)(65M)
Fe	none	(1.0000)(57M)
Pb	none	(1.0000)(208M) + (1.0000)(207M) + (1.0000)(206M)
Mg	none	(1.0000)(25M)
Mn	none	(1.0000)(55M)
Ni	none	(1.0000)(60M)
K	none	(1.0000)(39M)
Se	Ar2	(1.0000)(78M) - (1.1869)(76M)
Ag	none	(1.0000)(107M)
Na	none	(1.0000)(23M)
Tl	none	(1.0000)(205M)
V	CIO, Cr	(1.0000)(51M) - (3.1081)(53M) + (0.3524)(52M)
Zn	none	(1.0000)(66M)
6Li	Li (natural)	(1.0000)(6M) - (0.0813)(7M)
Sc	none	(1.0000)(45M)
Y	none	(1.0000)(89M)
Rh	none	(1.0000)(103M)
In	Sn	(1.0000)(115M) - (0.0149)(118M)
Tb	none	(1.0000)(159M)
Ho	none	(1.0000)(165M)
Bi	none	(1.0000)(209M)

M = Total ion count rate at the specified mass

TABLE II: Isobaric Molecular-Ion Interferences Which Could Affect the Analytes

Analyte	Interferences						
	Oxygen	**Hydroxyl**	**Nitrogen**	**Chlorine**	**Sulfur**	**Carbon**	**Other**
^{121}Sb	PdO		AgN			AgC	
^{123}Sb	AgO		AgN	SrCl	ZrS	CdC	
^{75}As	CoO	NiOH	NiN	ArCl	CaS	CuC	
^{138}Ba	SnO	SbOH					
^{137}Ba	SbO	SnOH		MoCl			
^{136}Ba	SnO	SnOH				SnC	
^{135}Ba	SnO	SnOH		MoCl			
^{134}Ba	SnO	SnOH	SnN	MoCl		SnC	
^{132}Ba	SnO, CdO	InOH	SnN	MoCl	MoS	SnC	
^{130}Ba	CdO	CdOH	SnN, CdN	MoCl	MoS	SnC	
^{9}Be							
^{114}Cd	MoO	MoOH	MoN	SeCl	SeS		
^{112}Cd	MoO, ZrO	MoOH	MoN	AsCl, SeCl	SeS	MoC	
^{111}Cd	MoO	MoOH	MoN	GeCl			
^{110}Cd	MoO, ZrO		MoN, ZrN	GeCl, AsCl	SeS	MoC	
^{113}Cd	MoO	MoOH		SeCl, AsCl			
^{116}Cd	MoO						
^{106}Cd	ZrO		MoN, ZrN		GeS	MoC, ZrC	
^{108}Cd	MoO, ZrO	ZrOH	MoN, ZrN	GeCl	SeS, GeS	MoC, ZrC	
^{52}Cr	ArO	ClOH				ArC	
^{53}Cr	ClO	ArOH	KN	NCl, OCl		KC	
^{50}Cr	SO		ArN		SO	ArC	Mo^{++}
^{54}Cr		ClOH	ArN, CaN			CaC	
^{59}Cr	CaO	CaOH	ScN	MgCl	AlS	TiC	Sn^{++}
^{63}Cu	TiO, PO_2	TiOH	TiN	SiCl, MgCl	PS	VC	ArNa
^{65}Cu	TiO	TiOH	VN	SiCl	SS,SO_2H	CrC	
^{208}Pb							
^{206}Pb							
^{207}Pb							
^{204}Pb							
^{55}Mn	KO	ArOH	KN		NaS	CaC	Cd^{++}

TABLE II: (cont.) Isobaric Molecular-Ion Interferences Which Could Affect the Analytes

Analyte	Interferences Oxygen	Hydroxyl	Nitrogen	Chlorine	Sulfur	Carbon	Other
^{202}Hg	WO						
^{200}Hg	WO	WOH	WN				
^{199}Hg	WO	WOH					
^{201}Hg		WOH					
^{198}Hg	WO	TaOH	WN			WC	
^{204}Hg							
^{196}Hg			WN				
^{58}Ni	CaO	KOH	CaN	NaCl	MgS	TiC	Cd^{++}, Sn^{++}
^{60}Ni	CaO	CaOH	TiN	MgCl, NaCl	SiS	TiC	Sn^{++}
^{62}Ni	TiO	ScOH	TiN	AlCl, MgCl	SiS	TiC, CrC	Sn^{++}
^{61}Ni	SeO	CaOH	TiN	MgCl	SiS	TiC	
^{64}Ni	TiO	TiOH	TiN, CrN	SiCl, AlCl	SS	CrC	
^{80}Se	ZnO	CuOH	ZnN	ScCl, CaCl	TiS	ZnC	
^{78}Se	NiO	NiOH	ZnN	CaCl, KCl	TiS	ZnC	
^{82}Se	ZnO	CuOH	ZnN	TiCl, ScCl	TiS, CrS		
^{76}Se	NiO	CoOH	NiN	KCl	CaS	ZnC	
^{77}Se	NiO	CuN	CuN	CaCl, ArCl	ScS	CuC	
^{74}Se	NiO	NiN	NiN	ClCl, KCl	CaS	NiC	
^{107}Ag	ZrO	ZrOH		GeCl	AsS	MoC	
^{109}Ag		MoOH	MoN	GeCl	SeS	MoC	
^{205}Tl							
^{203}Tl		WOH					
^{51}V	ClO	SOH	ClN	ClO, ClN	FS	KC	
^{50}V	SO		ArN			ArC	Mo
^{64}Zn	TiO	TiOH	TiN, CrN	SiCl, AlCl	SS	CrC	
^{66}Zn	TiO	TiOH	CrN	PCl, SiCl	SS	FeC	
^{68}Zn	CrO	VOH	FeN	PCl	ArS	FeC	Ba^{++}
^{67}Zn	VO	TiOH, Cr	CrN	SCl	ClS	MnC	Ba^{++}
^{70}Zn	FeO	CrOH	GeN	ClCl	ArS	NiC	

Note: The information provided in this table does not indicate that all of the described interferences need to be tested. However, the table can be consulted for informational purposes if unusual samples are encountered.

Table III: Changes in Isobaric Molecular-Ion Interferences with Changing Plasma Conditions**

	Molecular Interference	Nebulizer Flow Rate		
		High	Average	Low
Oxides:	ScO/Sc	0.00326	0.00055	0.00116
	YO/Y	0.00568	0.00395	0.00353
	TbO/Tb	0.0156	0.00648	0.00614
	ClO, Cl	0.00725	0.00227	0.00233
Hydroxides:	ScOH/Sc	0.00040	0.00011	0.00000
	YOH/Y	0.00078	0.00044	0.00048
	TbOH/Tb	0.00034	0.00008	0.00011
	ClOH/Cl	0.00048	0.00031	0.00029
Chlorine:	ClO/Cl	0.00725	0.00227	0.00233
	ClOH/Cl	0.00048	0.00031	0.00029
	ArCl/Cl	0.00605	0.00091	0.00477

** Information for this table is being determined by the EPA.

Table IV: Recommended Internal Standards

Method 6020	Method 200.8
Li	Sc
Sc	Y
Y	In
Rh	Tb
In	Bi
Tb	
Ho	
Bi	
Ge	

Table V: Interference Check Sample Components and Concentrations

(ICSAB minors are suggested spike levels)

Interference Component	Solution A Concentration (mg/L)	Solution AB Concentration (mg/L)
Al	50	50
Ca	50	50
Fe	50	50
Mg	50	50
Na	50	50
P	50	50
K	50	50
S	50	50
C	100	100
Cl	500	500
Mo	1.0	1.0
Ti	1.0	1.0
As	0.0	0.1
Cd	0.0	0.1
Cr	0.0	0.1
Co	0.0	0.1
Cu	0.0	0.1
Mn	0.0	0.1
Ni	0.0	0.1
Se	0.0	0.1
Ag	0.0	0.1
V	0.0	0.1
Zn	0.0	0.1

Table VI: Sample Preservation and Holding Times

Measurement Parameter	**Container (1)**	**Preservative (2)**	**Maximum Holding Time (3)**
Waters:			
Metals (4)	P,G	HNO_3 to pH < 2	6 months
Soils/Sediments/Wastes:			
The preservation required for soil/sediment/waste samples is maintenance at 4°C (± 2°C) until digestion.			

Footnotes:

(1) Polyethylene (P) or glass (G).

(2) Sample preservation is performed by the sampler immediately upon sample collection.

(3) Samples must be analyzed as soon as possible after collection. The times listed are the maximum times that sample may be held before analysis and still considered valid. Holding times are calculated from the date when the sample was collected.

(4) Samples are filtered immediately on-site by the sampler before adding preservative for dissolved elements.

Table VII: Suggested Mass Choices

Boldface masses indicate the masses which must have the most impact on data quality and the elemental equations used to collect the data. Suggested masses for method 200.8 are in "quotes".

Mass	Element of Interest
"**27**"	Aluminum
121, "**123**"	Antimony
"75"	Arsenic
138, "137", 136, **135**, 134, 132, 130	Barium
"9"	Beryllium
114, 112, "111", 110, 113, 116, 106	Cadmium
42, 43, **44**, 46, 48	Calcium
"**52**", **53**, **50**, 54	Chromium
"**59**"	Cobalt
"**63**", **65**	Copper
56, **54**, **57**, 58	Iron
"**208**", "**207**", "**206**", 204	Lead
24, **25**, **26**	Magnesium
"**55**"	Manganese
58, "**60**", 62, **61**, 64	Nickel
39	Potassium
80, **78**, "**82**", **76**, **77**, 74	Selenium
"**107**", **109**	Silver
23	Sodium
"**205**", 203	Thallium
"**51**", **50**	Vanadium
64, "**66**", **68**, **67**, 70	Zinc
72	Germanium
139	Lanthanum
118	Tin
35, 37	Chlorine
"98", 96, 92, **97**, 94	Molybdenum

Note: It is strongly recommended that elements other than those of interest be monitored to indicate other potential molecular interferences which could affect the data quality.

Table VIII: Tuning Solution

A tuning solution containing elements representing all of the mass regions of interest must be analyzed. Below are two groups of suggested solutions which cover a typical mass calibration range.

Method 6020

Element	Concentration (mg/L)
Solution A	
Mg	10.
Rh	10.
Pb	10.
Solution B	
Li	10.
Co	10.
In	10.
Tl	10.

Method 200.8

Element	Concentration (mg/L)
Be	10.
Mg	10.
Co	10.
In	10.
Pb	10.

Table IX: Suggested Tuning and Response Factor Criteria

Minimum Response from Tuning Solution

With a Peristalic Pump Speed of 12 RPM:

Be	>1,000
Mg	>10,000
Rh	>100,000
Pb	>50,000
Li	>2,000
Co	>20,000
In	>1,000
Tl	>1,000

Suggested Mass Calibration:

Be	9.0122
Mg	23.98
Rh	102.91
Pb	207.98
Li	7.016
Co	58.9332
In	114.904
Tl	204.9744

Table X: Summary of Quality Control Requirements

QC Parameter	Frequency*	Acceptance Criteria	Corrective Action
ICV/QCS	Beginning of every analytical run.	90 - 110% recovery.	Terminate analysis; correct the problem; recalibrate.
ICB/CB	Immediately after each ICV	The result must be < RL.	Terminate analysis; correct the problem; recalibrate.
CCV	Beginning and end of run and every 10 samples.	**6020-** 90 - 110% recovery. **200.8-** 85-115% recovery.	If unacceptable, correct the problem recalibrate the instrument, reverify calibration and rerun all samples associated with unacceptable CCV's.
CCB	Immediately following each CCV.	The result must be < RL.	If unacceptable, correct the problem recalibrate the instrument, reverify calibration and rerun all samples associated with unacceptable CCB's.
ICSA (6020 Only)	Beginning and every 12 hours.	Monitor for possible interferences.	See Section 9.12
ICSAB (6020 Only)	Immediately following each ICSA.	Monitor for possible interferences.	See Section 9.12

Table X (cont.) Summary of Quality Control Requirements

QC Parameter	Frequency*	Acceptance Criteria	Corrective Action
Method Blank/Laboratory Reagent Blank	One per lot of 20 field samples or fewer.	The result must be < RL. Sample results greater than 20x the blank concentration or samples for which the contaminant is < RL, do not require redigestion or reanalysis.	Redigest and reanalyze samples. See Section 9.3 for additional requirements.
Laboratory Control Sample/Laboratory Fortified Blank	One per lot of 20 field samples or fewer.	80-120%, or in-house limits (6020), 85-115% (200.8)	Redigest and reanalyze samples. See Section 9.4.
Serial Dilution (6020 Only)	One per lot of 20 field samples or fewer.	90 – 110% recovery	See section 9.14 for additional requirements.
Post-Digestion Spike (6020 Only)	See section 9.15	75-125% recovery	See section 9.15.
Matrix Spike/Matrix Spike Duplicate	One per lot of 20 field samples or fewer.	Must be within laboratory control limits	See section 9.5 for additional requirements.

Table XI: ICP/MS Calibration and Calibration Verification Checklist

Suggested Levels in mg/L

Element	Calibration			ICV	CCV
	1	2	3		
Aluminum	1000	5000	10000	25	50
Antimony	10	50	100	25	50
Arsenic	10	50	100	25	50
Barium	10	50	100	25	50
Beryllium	10	50	100	25	50
Cadmium	10	50	100	25	50
Chromium	10	50	100	25	50
Cobalt	10	50	100	25	50
Copper	10	50	100	25	50
Iron	1000	5000	10000	25	50
Lead	10	50	100	25	50
Manganese	10	50	100	25	50
Nickel	10	50	100	25	50
Selenium	10	50	100	25	50
Silver	10	50	100	25	50
Thallium	10	50	100	25	50
Vanadium	10	50	100	25	50
Zinc	10	50	100	25	50

This procedure has been developed for additional elements. Additional elements may be included in the calibration solution at the appropriate levels. Levels may be adjusted to meet specific regulatory or client programs.

Table XII: Suggested ICP/MS Reporting Limits

Water 6020 and 200.8 Solid 6020 (only)

	Compound	RL	Units	RL	Units
	Aluminum	50	ug/L	--	--
	Antimony	2	ug/L	200	ug/kg
	Arsenic	5	ug/L	500	ug/kg
	Barium	5	ug/L	500	ug/kg
	Beryllium	1	ug/L	100	ug/kg
	Cadmium	1	ug/L	100	ug/kg
	Chromium	2	ug/L	200	ug/kg
	Cobalt	1	ug/L	100	ug/kg
	Copper	5	ug/L	500	ug/kg
	Iron	20	ug/L	--	--
	Lead	1	ug/L	100	ug/kg
	Manganese	5	ug/L	500	ug/kg
	Molybdenum	2	ug/L	200	ug/kg
	Nickel	2	ug/L	100	ug/kg
	Selenium	5	ug/L	500	ug/kg
	Silver	1	ug/L	100	ug/kg
	Thallium	1	ug/L	100	ug/kg
	Tin	10	ug/L	1000	ug/kg
	Vanadium	5	ug/L	500	ug/kg
	Zinc	10	ug/L	1000	ug/kg

APPENDIX A – OPERATION INSTRUCTIONS – P.E. 6100

ICP/MS INSTRUCTIONS

A. Light the plasma and start the peristaltic pump.

1. Allow the instrument to warm up approximately 30 minutes.

B. Daily Performance

1. Open Daily2_asx workplace.
2. Open the sampling tab in the method screen.
3. Select and initialize the autosampler. Click O.K.
4. Click on probe. Click go to rinse. Send probe to tube #8.
5. Allow solution to reach plasma and then click on analyze sample.
6. When analysis is complete, send probe back to rinse.

C. Analysis Setup

1. Open Analysis workspace.
2. Under the method window, open the report tab and type in your report filename. Save the method.
3. Highlight the dataset window. Go to file and select new. Type in the dataset name (normally the same as the filename).
4. Highlight autosampler window. Type in your autosampler locations and samples. Right click under measurement action and select what needs to be analyzed. Right click under method description and select method. Verify that all times and rpms on table are correct. Go to file and click save as. Type autosampler table name (normally the same as the filename).

D. Analyze samples

1. Highlight samples to be analyzed.
2. Left click on analyze batch.

APPENDIX B – OPTIMIZATIONS – P.E. 6100

X-Y ADJUSTMENT – Adjusts torch to achieve best intensities. This should be done whenever anything is done to the torch or the cones.

1. Open X-Y_asx.wrk.
2. Under the method window, go to the sampling tab and send the probe to tube #8.
3. Allow solution to reach plasma and hit analyze sample.
4. Adjust x and y while watching the signal on the realtime window. Adjust only until signal is at its highest.

NEB LENS – This also is done to get best intensities. It effects the shape and the depth of the plasma. This should be done if your oxides or doubly charged are >3%.

1. Open neb lens power oxides.wrk
2. Under the method window, go to the sampling tab and send the probe to tube #8.
3. Click on the Autooptimize tab. Select nebulizer gas flow.
4. Click get analyte list.
5. Make sure solution has reached the plasma and click optimize.
6. When done, save the optimization file.

AUTOLENS – Each element done represents a section of the mass spectrum. Be is on the low end, CO is in the middle and IN is on the higher end. If there is a problem with any particular section of the spectrum, it may be an indication that this needs done. This should probably be performed on a weekly basis.

1. Open Autolens_asx.wrk.
2. Under the method window, go to the sampling tab and send the probe to tube #8.
3. Click on the autolens tab.
4. Click on clear calibration.
5. Click on get analyte list.

6. Make sure the solution has reached the plasma and click on calibrate.
7. Save the optimization file.
8. In the interactive window, the optimization curve can be printed.

DUAL DETECTOR CALIBRATION – This extends the dynamic range of the detector. This should be done on a weekly basis. All analytes of interest must be included in the solution.

1. Open dual detector2.wrk
2. Under the method window, go to the sampling tab and send the probe to tube #8.
3. Click on dual detector cal tab.
4. Click on clear calibration.
5. Click on get analyte list.
6. Make sure the solution has reached the plasma and click on calibrate.
7. When complete, check to make sure that all r values are at least .999.
8. Save the optimization file.
9. In the interactive window, the plots can be displayed.

TUNING – This adjusts the electronics to assure the accuracy of the mass spec. The resolution adjustment assures that the resolution of each mass of interest is within range. This should be done daily.

1. Open tuning_asx.wrk.
2. Under the method window, go to the sampling tab and send the probe to tube #8.
3. Allow sample to reach the plasma and click on tune mass spec.
4. Make sure measured mass and peak width is within range. If its not, resolution will need adjusted. Adding 30 units will decrease the amu by about 0.1. Subtracting 30 units will increase the amu about 0.1.

GENERAL NOTES –

1. All optimizations can be done with the tuning solution, except the dual detector cal needs the cross cal standard with all the elements of interest.

2. All optimizations can be run at 12 rpm, except the dual detector calibration should be done at 24 rpm.

Appendix D – ICPMS Maintenance Schedule

Daily

Change sample and internal standard pump tubing and pump windings

Check argon gas supply level

Check rinse solution and fill if needed

Check waste containers and empty if needed

Check sample capillary tubing is clean and in good condition

Check sample flow for cross flow nebulizer

Check pressure for vacuum systems

Check daily performance

As Needed

Clean Sampler and skimmer cones

Clean plasma torch assembly to remove accumulated deposits

Clean nebulizer

Replace sample and internal standard capillary tubing and autosampler sipper probe

Replace drain tubing

Perform necessary optimizations

Clean autolens

Monthly

Inspect air filters; clean or replace as needed

Bi-Yearly

Change oil in vacuum pumps

Check water in coolflow

STL STANDARD OPERATING PROCEDURE

TITLE: ACID DIGESTION OF AQUEOUS SAMPLES BY SW846 AND MCAWW 200 SERIES METHODS

(Supersedes: Revision 1.4, Dated 02/19/03)

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1. SCOPE AND APPLICATION

1.1. This procedure describes the preparation of aqueous samples for the analysis of certain metals by Graphite Furnace Atomic Absorption (GFAA), Flame Atomic Absorption (FLAA), Inductively Coupled Plasma Atomic Emission Spectroscopy (ICP), and Inductively Coupled Plasma-Mass Spectrometry (ICP/MS) using the MCAWW 200 series methods (NPDES) and SW846 Methods 3005A, 3010A, 3020A and 7060A/7740 (RCRA).

1.2. The applicability of each of these preparation protocols to specific analytes is detailed in Tables I and II (Appendix A) and the applicable determinative methods are illustrated by Figures 6 and 7 (Section 17). Additional elements may be analyzed following digestion by these protocols provided that the method performance criteria specified in Section 13.0 of this SOP are met.

1.3. This SOP provides procedures applicable to the preparation of dissolved, suspended, total recoverable and total elements in ground water, aqueous samples, certain aqueous sludges, wastes, and biological tissues, and leachates/extracts.

1.4. SW-846 Method 3005A is used to prepare surface and groundwater samples for total recoverable and dissolved metals determination by FLAA, ICP and GFAA (antimony only).

1.5. MCAWW Method 200.7 Section 9.4 is used to prepare surface water, domestic and industrial waste samples for total recoverable and dissolved metals determination by ICP.

1.6. SW-846 Method 3010A is used to prepare aqueous samples, EP and mobility-procedure extracts, and wastes that contain suspended solids for total metals analysis by FLAA or ICP.

1.7. MCAWW Method 200.7 Section 9.3 is used to prepare surface water and wastes that contain suspended solids for total metals analysis by ICP.

1.8. MCAWW Methods 206.2 and 270.2, respectively, contain the procedure for the preparation of aqueous samples for arsenic and selenium.

1.9. All matrices require digestion prior to analysis with the exception of analyses for dissolved metals in filtered and acidified aqueous samples. Although digestion is not specifically

required by the method, some clients and regulators do require digestion of dissolved samples and this must be clarified before project initiation.

2. SUMMARY OF METHOD

2.1. Method 3005A / Method 200.7 Section 9.4 - Preparation for Total Recoverable or Dissolved Metals Analysis by FLAA or ICP Spectroscopy

2.1.1. A representative aliquot of sample is heated with nitric and hydrochloric acids and substantially reduced in volume. The digestate is filtered (if necessary) and diluted to volume.

2.2. Method 3010A / Method 200.7 Section 9.3 - Preparation for Total Metals Analysis by FLAA or ICP Spectroscopy

2.2.1. A representative aliquot of sample is refluxed with nitric acid. After the digestate has been reduced to a low volume, it is refluxed with hydrochloric acid, filtered (if necessary) and brought up to volume.

2.3. Method 200.0 Section 4.1.4 - Total Recoverable GFAA Preparation (NPDES)

A representative aliquot of sample is heated with nitric acid and until the digestate has been reduced to a low volume. The sample is cooled, filtered (if necessary) and brought up to volume.

3. DEFINITIONS

Additional definitions of terms used in this SOP may be found in the glossary of the LQM.

3.1. Dissolved Metals: Those elements which pass through a 0.45 um membrane. (Sample is acidified after filtration).

3.2. Suspended Metals: Those elements which are retained by a 0.45 um membrane.

3.3. Total Metals: The concentration determined on an unfiltered sample following digestion.

3.4. Total Recoverable Metals: The concentration determined on an unfiltered sample following treatment with hot, dilute mineral acid.

4. INTERFERENCES

4.1. There are numerous routes by which samples may become contaminated. Potential sources of trace metals contamination include: metallic or metal-containing labware (e.g., talc gloves which contain high levels of zinc), containers, impure reagents, dirty glassware, improper sample transfers, dirty work areas, atmospheric inputs such as dirt and dust, etc. Be aware of potential sources of contamination and take appropriate measures to minimize or avoid them.

4.2. The entire work area, including the bench top and fume hood, should be thoroughly cleaned on a routine schedule in order to minimize the potential for environmental contamination. Refer to Appendix B for additional contamination control guidelines.

4.3. Boron and silica from the glassware will migrate into the sample solution during and following sample processing. For critical low level determinations of boron and silica, only quartz and/or plastic labware should be used.

4.4. Physical interference effects may contribute to inaccuracies in the determinations of trace elements. Oils, solvents and other matrices may not be digested using these methods if they are not soluble with acids. If physical interferences are present, they should be documented.

4.5. Visual interferences or anomalies (such as foaming, emulsions, precipitates, etc.) must be documented.

4.6. Allowing samples to boil or go dry during digestion may result in the loss of volatile metals. If this occurs the sample must be reprepared. Antimony is easily lost by volatilization from hydrochloric acid media.

4.7. Precipitation of silver chloride (AgCl) may occur when chloride ions and high concentrations of silver (i.e., greater than 1 mg/L) are present in the sample.

4.8. Specific analytical interferences are discussed in each of the determinative methods.

5. SAFETY

5.1. Employees must abide by the policies and procedures in the Corporate Safety and this document.

5.2. Samples that contain high concentrations of carbonates or organic material or samples that are at elevated pH can react violently when acids are added.

5.3. The following is a list of the materials used in this method, which have a serious or significant hazard rating. **NOTE: This list does not include all materials used in the method. The table contains a summary of the primary hazards listed in the MSDS for each of the materials listed in the table.** A complete list of materials used in the method can be found in the reagents and materials section. Employees must review the information in the MSDS for each material before using it for the first time or when there are major changes to the MSDS.

Material (1)	**Hazards**	**Exposure Limit (2)**	**Signs and symptoms of exposure**
Hydrochloric Acid	Corrosive Poison	5 ppm-Ceiling	Inhalation of vapors can cause coughing, choking, inflammation of the nose, throat, and upper respiratory tract, and in severe cases, pulmonary edema, circulatory failure, and death. Can cause redness, pain, and severe skin burns. Vapors are irritating and may cause damage to the eyes. Contact may cause severe burns and permanent eye damage.
Hydrogen Peroxide	Oxidizer Corrosive	1 ppm-TWA	Vapors are corrosive and irritating to the respiratory tract. Vapors are very corrosive and irritating to the eyes and skin.
Nitric Acid	Corrosive Oxidizer Poison	2 ppm-TWA 4 ppm-STEL	Nitric acid is extremely hazardous; it is corrosive, reactive, an oxidizer, and a poison. Inhalation of vapors can cause breathing difficulties and lead to pneumonia and pulmonary edema, which may be fatal. Other symptoms may include coughing, choking, and irritation of the nose, throat, and respiratory tract. Can cause redness, pain, and severe skin burns. Concentrated solutions cause deep ulcers and stain skin a yellow or yellow-brown color. Vapors are irritating and may cause damage to the eyes. Contact may cause severe burns and permanent eye damage.
1 – Always add acid to water to prevent violent reactions.			

2 – Exposure limit refers to the OSHA regulatory exposure limit.

5.4. Eye protection that protects against splash, laboratory coat, and appropriate gloves must be worn while samples, standards, solvents, and reagents are being handled. Cut resistant gloves must be worn doing any other task that presents a strong possibility of getting cut. Disposable gloves that have been contaminated will be removed and discarded; other gloves will be cleaned immediately.

5.5. The acidification of samples containing reactive materials may result in the release of toxic gases, such as cyanides or sulfides. Acidification of samples should be done in a fume hood. The analyst should also be aware of the potential for a vigorous reaction.

5.6. Exposure to chemicals must be maintained **as low as reasonably achievable.** Therefore, unless they are known to be non-hazardous, all samples should be opened, transferred and prepared in a fume hood, or under other means of mechanical ventilation. All samples with pink stickers that read "Caution/Use Hood!" **must** be opened in the hood. Contact the EH&S Coordinator if this is not possible. Solvent and waste containers will be kept closed unless transfers are being made.

5.7. All work must be stopped in the event of a known or potential compromise to the health and safety of a STL associate. The situation must be reported **immediately** to the EH&S Coordinator and the Laboratory Supervisor.

5.8. Always carry bulk concentrated acid bottles in appropriate impact proof containers.

5.9. Acid/peroxide spills must be neutralized immediately, flushed with water and cleaned up using appropriate spill kits.

5.10. Discard chipped or broken beakers to prevent injury. Chipped glassware may be fire polished as an alternative to disposal.

6. EQUIPMENT AND SUPPLIES

6.1. Hot plate, digestion block or other adjustable heating source capable of maintaining a temperature of 95°C (± 4).

6.2. Calibrated thermometer that covers a temperature range of 0-200°C.

6.3. Griffin beakers of assorted sizes or equivalent.

6.4. Watch glasses, ribbed or equivalent.

6.5. Whatman No. 4 filter paper or equivalent.

6.6. Funnels or equivalent filtration apparatus.

6.7. Centrifugation equipment (if desired method of removing particulates is centrifugation).

6.8. Graduated cylinder or equivalent capable of measuring 50 mL within 3% accuracy.

6.9. Analytical balance capable of accurately weighing to the nearest 0.01 grams.

6.10. Repipetors or suitable reagent dispensers.

6.11. Calibrated automatic pipettes with corresponding pipette tips or Class A glass volumetric pipettes.

6.12. Class A volumetric flasks.

6.13. pH indicator strips (pH range 0 - 6).

6.14. Plastic digestate storage bottles.

7. REAGENTS AND STANDARDS

7.1. Reagent water must be produced by a Millipore DI system or equivalent. Reagent water must be free of the analytes of interest as demonstrated through the analysis of method blanks as defined in the determinative SOPs.

7.2. Laboratory Control Sample (LCS) and matrix spike (MS) solutions are purchased as custom STL solutions. All standards must be stored in FEP fluorocarbon or previously unused polyethylene or polypropylene bottles. Stock standard solutions must be replaced prior to the expiration date provided by the manufacturer. If no expiration date is provided, the stock solutions may be used for up to one year and must be replaced sooner if verification from an independent source indicates a problem.

7.3. Working ICP LCS/MS spike solution: Prepare the ICP LCS/MS working spike solution from custom stock standards to the final concentration listed in Table III. The working

spike must be prepared in a matrix of 5% HNO_3. This acid (5 mL of concentrated HNO_3 per 100 mL) must be added to the volumetric flask before the addition of the stock standard aliquot. The working ICP LCS solution must be made fresh every three months.

7.4. Working GFAA LCS/MS spike solution: Prepare the GFAA working LCS spike solution by diluting the custom stock solution (7.2) 200x. The working spike solution must be prepared in a matrix of 5% HNO_3. This acid (5 mL of concentrated HNO_3 per 100 mL) must be added to the volumetric flask before the addition of the stock standard aliquot. The working GFAA LCS solution must be made fresh every three months.

7.5. The TCLP MS working spike solution is provided directly by the vendor, no further standard preparation is necessary.

7.6. The LCS and MS samples must contain all the elements designated for analysis in each batch of samples. If a non-routine element is required that is not contained in the custom STL solution, the individual facility must purchase a solution from the designated vendor that will cover the additional analyte(s) of interest and provide for a final spike concentration that is appropriate to the determinative method.

7.7. Aqueous laboratory control samples (LCSW) and matrix spike samples are prepared as described in Sections 9.5 and 9.6. Refer to Tables III and IV(Appendix A) for details regarding the stock, working standard and final digestate spike concentrations for ICP and GFAA LCS and matrix spike preparations.

7.8. Nitric acid (HNO_3), concentrated, trace metal grade or better.

7.9. Nitric acid, 1:1 - dilute concentrated HNO_3 with an equal volume of reagent water.

Note: When preparing diluted acids always add acid to water. If the water is added to the acid a violent reaction may occur.

7.10. Hydrochloric acid (HCl), concentrated, trace metal grade or better.

7.11. Hydrochloric acid, 1:1 - dilute concentrated HCl with an equal volume of reagent water.

Note: When preparing diluted acids always add acid to water. If the water is added to the acid a violent reaction may occur.

7.12. 30% Hydrogen peroxide (H_2O_2), reagent grade.

8. SAMPLE COLLECTION, PRESERVATION AND STORAGE

8.1. Sample holding time for metals included under the scope of this SOP is 180 days from the date of collection to the date of analysis.

8.2. Aqueous samples are preserved with nitric acid to a pH of <2 and may be stored in either plastic or glass. If boron or silica are to be determined, plastic containers are preferred. Refrigeration is not required. Preservation must be verified prior to analysis.

8.3. For dissolved metals analysis, the samples should be filtered through a 0.45 um filter prior to preservation. Filtration must be done in the field or within 24 hours of collection.

Note: If a sample being analyzed for dissolved metals is found to contain sediment the analyst should contact their supervisor or group leader. The client should be notified of the problem to decide how to treat the sample.

9. QUALITY CONTROL

Table VI (Appendix A) provides a summary of quality control requirements including type, frequency, acceptance criteria and corrective action.

9.1. Initial Demonstration of Capability

Prior to analysis of any analyte using any method contained within this SOP the following requirements must be met:

9.1.1. Method Detection Limit (MDL) - An MDL must be determined for each analyte/matrix prior to the analysis of any samples. The MDL is determined using seven replicates of reagent water, spiked with all the analytes of interest, that have been carried through the entire analytical procedure. MDL's must be redetermined on an annual basis in accordance with 40 CFR Part 136 Appendix B requirements as detailed in STL QA Policy QA-005. The spike level must be between the calculated MDL and 10X the MDL to be valid. The result of the MDL determination must be below the STL reporting limit.

9.1.2. Initial Demonstration Study - This requires the analysis of four QC check samples. The QC check sample is a well-characterized laboratory generated sample used to monitor method performance, which should contain all the analytes of interest. The results of the initial demonstration study must be acceptable before analysis of samples may begin. The results of the initial demonstration study may be used to

extend a method for the analysis of other elements provided all acceptance criteria are met.

9.1.2.1. Four aliquots of the check sample (LCS) are prepared and analyzed using the procedures detailed in this SOP and the determinative SOPs.

9.1.2.2. Calculations and acceptance criteria for QC check samples are given in the determinative SOPs (CORP-MT-0001, CORP-MT-0003).

9.2. Preparation Batch - A group of up to 20 samples that are of the same matrix and are processed together using the same procedures and reagents. The preparation batch must contain a method blank, a LCS and a matrix spike/matrix spike duplicate. In some cases, at client request, it may be appropriate to process a matrix spike and sample duplicate in place of the MS/MSD. If clients specify specific samples for MS/MSD, the batch may contain multiple MS/MSD pairs.

9.3. Sample Count - Laboratory generated QC samples (method blanks, LCS) are not included in the sample count for determining the size of a preparation batch. MS/MSD are not included in the sample count unless there are multiple sets of MS/MSD per batch. In other words, the first MS/MSD are not counted; all additional MS and MSDs are counted as samples.

9.4. Method Blank (MB) - One method blank must be processed with each preparation batch. The method blank consists of reagent water containing all reagents specific to the method that is carried through the entire analytical procedure, including preparation and analysis. The method blank is used to identify any system and process interferences or contamination of the analytical system that may lead to the reporting of elevated analyte concentrations or false positive data. Criteria for the acceptance of blanks are contained within the individual analytical method SOP's. If the method blank does not meet the criteria contained within the analytical method SOPs; the blank and all associated samples in the batch must be redigested.

9.4.1. Aqueous method blanks are prepared by taking 50 mL or 50 g of reagent water through the appropriate procedure as described in Section 11.

9.4.2. TCLP method blanks are prepared by taking 50 mL or 50 g of leachate fluid through the appropriate procedure as described in Section 11.

9.5. Laboratory Control Sample (LCS) - One aqueous LCS must be processed with each preparation batch. The LCS must contain all analytes of interest and must be carried

through the entire analytical procedure. The LCS is used to monitor the accuracy of the analytical process. On going monitoring of the LCS results provides evidence that the laboratory is performing the method within acceptable accuracy and precision guidelines. Criteria for the acceptance of LCS results are contained within the individual analytical method SOP's. Corrective action when LCS results fail to meet control limits will be repreparation and reanalysis of the batch. Refer to Section 7.3 and 7.4 for instructions on preparation of the aqueous LCS spike solution.

9.5.1. The aqueous LCS is prepared by spiking a 50 mL aliquot of reagent water with 1.0 mL of the working LCS/MS spike solution (7.3 or 7.4). The LCS is then processed through the appropriate procedure as described in Section 11.

9.6. Matrix Spike/Matrix Spike Duplicate (MS/MSD) - One MS/MSD pair must be processed for each preparation batch. A matrix spike (MS) is a field sample to which known concentrations of target analytes have been added. A matrix spike duplicate (MSD) is a second aliquot of the same sample (spiked identically as the MS) prepared and analyzed along with the sample and matrix spike. Some client specific data quality objectives (DQO's) may require the use of sample duplicates in place of or in addition to MS/MSD's. The MS/MSD results are used to determine the effect of a matrix on the precision and accuracy of the analytical process. Samples identified as field blanks cannot be used for MS/MSD analysis. If any analyte recovery or RPD falls outside the acceptance range, the recovery of that analyte must be in control for the LCS. If the recovery of the LCS is outside limits, corrective action must be taken. Corrective action will include repreparation and reanalysis of the batch. Corrective action when MS results fail to meet control limits does not include repreparation of samples unless the results indicate that a spiking error may have occurred.

9.6.1. The aqueous matrix spike sample is prepared by spiking a 50 mL aliquot of a sample with 1.0 mL of the working LCS/MS spike solution (7.3 or 7.4). The matrix spike sample is then processed as described in Section 11.

9.6.2. The TCLP matrix spike sample is prepared by spiking a 50 mL aliquot of a leachate with 0.5 mL of the working TCLP spike solution (7.5). The matrix spike sample is then processed as described in Section 11.

NOTE: The TCLP matrix spike must be added prior to preservation of the leachate.

9.6.3. If insufficient sample is available to process a MS/MSD, then a second LCS must be processed. The LCS pair is then evaluated according to the MS/MSD criteria.

9.7. Quality Assurance Summaries - Certain clients may require specific project or program QC that may supersede the SOP requirements. Quality Assurance Summaries (QAS) should be developed to address these requirements.

10. CALIBRATION AND STANDARDIZATION

10.1 Hotplate temperature must be verified daily for each hotplate used and must be recorded on either the metals preparation log or in a hotplate temperature logbook. The hotplate temperature should be verified by measuring the temperature of a beaker of reagent water placed on each hotplate.

11. PROCEDURE

11.1. One time procedural variations are allowed only if deemed necessary in the professional judgment of supervision to accommodate variation in sample matrix, radioactivity, chemistry, sample size, or other parameters. Any variation in procedure shall be completely documented using a Nonconformance Memo and is approved by a Technical Specialist and QA Manager. If contractually required, the client shall be notified. The Nonconformance Memo shall be filed in the project file.

11.2. Any unauthorized deviations from this procedure must also be documented as a nonconformance, with a cause and corrective action described.

11.3. All digestion procedures must be carried out in a properly functioning hood.

11.4. All samples are to be checked out of sample control with the chain of custody documentation filled out completely.

11.5. Proper sample identification is extremely important in any preparation procedure. Labeling of beakers and bottles must be done in a manner to ensure connection with the proper sample.

11.6. Samples are typically logged in as either waters or soils. Wastes such as organic liquids or sludges and tissues (animal/vegetable) are usually logged in with solid test codes. When initiating prep, examine the sample to see if the sample matches the matrix designation. If the sample is logged in as aqueous but it appears more like a waste (biphasic, sludge like, organic liquid, lots of sediment etc.) contact the lab supervisor or project manager for further instructions. In some cases it may be more appropriate to process these samples as solids.

11.7. If possible prepare all the samples of a project at the same time to minimize the QC required and streamline the flow of the project through the lab and reporting group.

11.8. In most cases, both AA and ICP digests are required on each sample. It is recommended that both aliquots be measured out and processed at the same time.

11.9. Guidelines are provided in the appendices on procedures to minimize contamination of samples and standards.

11.10. The following procedure must be followed for all aqueous sample preparations:

11.10.1. Measure sample pH with pH paper on a separate aliquot of sample.

Note: If the sample pH is > 2 pH units, the client must be notified of the anomaly.

Note: If sample pH has already been verified and documented in sample receipt this step may be omitted.

11.10.2. Mix sample by shaking the container.

11.10.3. Measure and transfer 50 mL or 50 g of the sample into a beaker.

Note: This SOP allows for samples to be weighed instead of measured volumetrically.

11.10.4. Measure two extra aliquots of sample selected for the MS/MSD analysis. Spike each aliquot with the appropriate spiking solutions (7.3-7.5,9.6).

11.10.5. Measure and transfer 50 mL of reagent water into a beaker for the method blank.

11.10.6. Measure and transfer 50 mL of reagent water into a beaker for the LCS and add the appropriate spiking solutions (7.3-7.5,9.6).

11.11. Proceed to the appropriate Section for the desired method as follows:

Method 3005A or Method 200.7 Section 9.4	11.12
Method 3010A or Method 200.7 Section 9.3	11.13
Method 3020A or Method 200.0 Section 4.1.3	11.14
Method 7060A/7740 or Method 206.2/270.2	11.15
Method 200.0 Section 4.1.4	11.16

11.12. **Method 3005A / Method 200.7 Section 9.4 - Preparation for Total Recoverable or Dissolved Metals Analysis by FLAA or ICP (See Figures 1, 6 and 7)**

11.12.1. To the sample beaker, add 1 mL of concentrated HNO_3 and 2.5 mL of concentrated HCl.

11.12.2. Cover with ribbed watch glass.

11.12.3. Heat at 95°C (± 4) until volume is reduced to between 15 and 20 mL.

NOTE: DO NOT ALLOW SAMPLE TO BOIL OR GO DRY. Doing so will result in the loss of analyte and the sample must be reprepared.

11.12.4. Cool the beaker in a fume hood.

11.12.5. Wash down beaker walls and watch glass with reagent water.

11.12.6. Filter sample, if insoluble materials are present, through Whatman 4 filter paper that has been pre-rinsed with dilute nitric acid.

Note: If any samples in a preparation batch are filtered, the method blank and LCS associated with that batch must also be filtered.

Note: In place of filtering, the samples, after dilution and mixing, may be centrifuged or allowed to settle by gravity overnight to remove insoluble material.

11.12.7. Rinse beaker and filter paper with reagent water to ensure complete sample transfer.

11.12.8. Adjust the final volume/mass to 50 mL or 50 g with reagent water. The sample is now ready for analysis

11.13. **Method 3010A / Method 200.7 Section 9.3 - Preparation for Total Metals Analysis by FLAA or ICP Spectroscopy (See Figures 2, 6 and 7)**

11.13.1. To the sample beaker, add 3.0mL of concentrated HNO_3.

11.13.2. Cover with ribbed watch glass.

11.13.3. Place beaker on hotplate 95°C (± 4) and evaporate for 4-5 hours or to low volume of 15-20 mL while ensuring that no portion of the bottom of the beaker is allowed to go dry.

NOTE: DO NOT ALLOW SAMPLE TO BOIL OR GO DRY. Doing so will result in the loss of analyte and the sample must be reprepared.

11.13.4. If necessary, add another 1.5 ml portion of concentrated HNO_3 and re-cover the beaker. Reflux 15 minutes.

11.13.5. Add 5 mL of 1:1 HCl.

11.13.6. Cover and reflux for an additional 15 minutes to dissolve precipitate or residue. Cool in a fume hood.

11.13.7. Wash down beaker walls and watch glass with reagent water.

11.13.8. Filter sample, if insoluble materials are present, through Whatman 4 filter paper.

Note: If any samples in the QC batch are filtered the method blank and LCS associated with that batch must also be filtered.

Note: In place of filtering, the samples, after dilution and mixing, may be centrifuged or allowed to settle by gravity overnight to remove insoluble material.

11.13.9. Rinse beaker and filter paper with reagent water to ensure complete sample transfer.

11.13.10. Adjust final volume/mass to 50 mL or 50 g with reagent water. The sample is now ready for analysis.

11.14. **Method 3020A / Method 200.0 Section 4.1.3 - Preparation for Total Metals Analysis by GFAA or Total Recoverable Metals by ICPMS (See Figures 3, 6 and 7)**

11.14.1. To the sample beaker, add 1.5 mL of concentrated HNO_3.

11.14.2. Cover with ribbed watch glass.

11.14.3. Place beaker on hotplate 95°C (± 4) and evaporate to low volume of 15-20 mL while ensuring that no portion of the bottom of the beaker is allowed to go dry.

NOTE: DO NOT ALLOW SAMPLE TO BOIL OR GO DRY. Doing so will result in the loss of analyte and the sample must be reprepared.

11.14.4. If necessary, add another 1.5 mL portion of concentrated HNO_3. Recover, and reflux 15 minutes. Cool the beaker in a fume hood.

11.14.5. Filter sample, if insoluble materials are present, through Whatman 4 filter paper.

Note: If any samples in the QC batch are filtered the method blank and LCS associated with that batch must also be filtered.

Note: In place of filtering, the samples, after dilution and mixing, may be centrifuged or allowed to settle by gravity overnight to remove insoluble material.

11.14.6. Rinse beaker and filter paper with reagent water to ensure complete sample transfer.

11.14.7. Adjust final volume to 50 mL with reagent water. The sample is now ready for analysis.

11.15. **Method 7060A/7740 and Method 206.2/270.2 - Preparation for Arsenic and Selenium Analysis by GFAA (See Figures 4, 6 and 7)**

11.15.1. To the sample beaker, add 1 mL of 30 % H_2O_2 and 1.0 mL of 1:1 HNO_3.

11.15.2. Heat, until the digestion is complete, at 95°C (± 4) or until the volume has been reduced to 15-20 mL.

11.15.3. Cool beaker.

11.15.4. Filter sample, if insoluble materials are present, through Whatman 4 filter paper that has been pre-rinsed with dilute nitric acid.

Note: If any samples in the QC batch are filtered the method blank and LCS associated with that batch must also be filtered.

Note: In place of filtering, the samples, after dilution and mixing, may be centrifuged or allowed to settle by gravity overnight to remove insoluble material.

11.15.5. Rinse beaker and filter paper with reagent water to ensure complete sample transfer.

11.15.6. Adjust final volume to 50 mL with reagent water. The sample is now ready for analysis.

11.16. **Method 200.0 Section 4.1.4 - Preparation for Total Recoverable GFAA Analyses. (See Figures 5 and 7)**

11.16.1. To the sample beaker, add 1.0 mL of 1:1 HNO_3.

11.16.2. Heat, until the digestion is complete, at 95°C (± 4) or until the volume has been reduced to 15 - 20 mL.

11.16.3. Cool beaker.

11.16.4. Filter sample, if insoluble materials are present, though Whatman 4 filter paper.

Note: If any samples in the QC batch are filtered the method blank and LCS associated with that batch must also be filtered.

Note: In place of filtering, the samples, after dilution and mixing, may be centrifuged or allowed to settle by gravity overnight to remove insoluble material.

11.16.5. Rinse beaker and filter paper with reagent water to ensure complete sample transfer.

11.16.6. Adjust final volume to 50 mL with reagent water. The sample is now ready for analysis.

12. DATA ANALYSIS AND CALCULATIONS

Not Applicable.

13. METHOD PERFORMANCE

13.1. Method performance is determined by the analysis of matrix spike and matrix spike duplicate samples as well as method blanks and laboratory control samples. In general, the matrix spike recovery should fall within +/- 20 % and the matrix spike duplicates should compare within 20% RPD. Method blanks must meet the criteria specified in determinative SOPs. The laboratory control samples should recover within 20% of the true value until in house control limits are established. Acceptance criteria are given in the determinative SOPs.

13.2. The initial demonstration study as detailed in Section 9.1.2 must be acceptable before the analysis of field samples under this SOP may begin. The results of the initial demonstration study may be used to extend a method for the analysis of other elements provided all acceptance criteria are met.

13.3. Training Qualification:

The group/team leader has the responsibility to ensure that this procedure is performed by an associate who has been properly trained in its use and has the required experience.

14. POLLUTION PREVENTION

14.1. This method allows for the proportional reduction of sample and reagent volumes to decrease waste generation.

15. WASTE MANAGEMENT

15.1. All waste will be disposed of in accordance with Federal, State and Local regulations. Where reasonably feasible, technological changes have been implemented to minimize the potential for pollution of the environment. Employees will abide by this method and the

policies in section 13 of the Corporate Safety Manual for "Waste Management and Pollution Prevention."

15.2. Waste Streams Produced by the Method

15.2.1. The following waste streams are produced when this method is carried out.

15.2.1.1. Acidic waste containing nitric acid generated by the extraction. This waste is disposed of in the designated container labeled "Acid Waste".

15.2.1.2. Contaminated disposable materials utilized for the analysis. This waste is disposed of in a designated container identified as "Solid Waste".

15.3. Laboratory personnel assigned to perform hazardous waste disposal procedures must have a working knowledge of the established procedures and practices of STL. They must have training on the hazardous waste disposal practices upon initial assignment to these tasks, followed by an annual refresher training.

16. REFERENCES

16.1. References

16.1.1. Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, SW-846, 3rd Edition, Final Update I, Revision 1, July 1992. Methods 3005A, 3010A, 3020A, 7060A and 7740A.

16.1.2. Methods for the Chemical Analysis of Water and Waste (MCAWW), 1983.

16.1.3. CORP-MT-0001, Inductively Coupled Plasma-Atomic Emission Spectroscopy, Spectrometric Method for Trace Element Analysis of Water and Wastes, Method 6010A and Method 200.7.

16.1.4. CORP-MT-0003, Graphite Furnace Atomic Absorption Spectroscopy, SW846 Method 7000A and MCAWW 200 Series Methods.

16.1.5. Corporate Quality Management Plan (QMP), current version.

16.1.6. STL Laboratory Quality Manual (LQM), current version.

16.1.7. STL Corporate Safety Manual, M-E-0001 and STL North Canton Facility Addendum and Contingency Plan, current version.

16.2. Associated SOPs and Policies, latest version

16.2.1. QA-003, STL QC Program.

16.2.2. QA-004, Rounding and Significant Figures.

16.2.3. Glassware Washing, NC-QA-0014

16.2.4. Statistical Evaluation of Data and Development of Control Charts, NC-QA-0018

16.2.5. Method Detection Limits and Instrument Detection Limits, S-Q-003 and NC-QA-0021

16.2.6. Navy/Army SOP, NC-QA-0016

17. MISCELLANEOUS (TABLES, APPENDICES, ETC. . .)

17.1. Modifications/Interpretations from reference methods.

17.1.1. Modifications applicable to SW-846 reference methods.

17.1.1.1. Chapter 1 of SW-846 states that the method blank should not contain any analyte of interest at or above the MDL. This SOP states that the method blank must not contain any analyte of interest at or above the reporting limit. Common lab contaminants are allowed up to two times the reporting limit in the blank following consultation with the client.

17.1.1.2. The referenced methods as well as Table 3-1 of SW-846 refer to the use of a 100 mL aliquot for digestion. This SOP requires the use of a 50 mL sample size to reduce waste generation. The use of reduced sample volumes are supported in EPA's document "Response to Public Comments Background Document, Promulgation of the Second Update to SW-846, Third Edition" dated November 3, 1994. This document stated "flexibility to alter digestion volumes is addressed and "allowed" by the table (3-1) and is also inherently allowed by specific digestion methods. Table 3-1 is only to be used as guidance when collecting samples..." EMSL-Ci has also taken the stance that "reduction in

sample size and appropriate corresponding reduction in sample volume is not considered a significant change in the methodology." Additionally, in written correspondence from the Office of Solid Waste, Olliver Fordham stated " As a "representative sample" can be assured, scaling causes no loss of precision and accuracy in the analysis."

17.1.2. Modifications Specific to Method 3010A

17.1.2.1. Section 11.13.7 of this SOP requires the sample be reduced to a volume of 15 - 20 mL. Section 7.2 of Method 3010A states the volume should be reduced to 3 mL but also states that no portion of the bottom of the beaker should go dry. The SOP required volume is a closer approximation of the volume required to provide an adequate covering of the beaker so as to prevent the loss of critical analytes through volatilization.

17.1.2.2. The scope of 3010A has been expanded to include silver based on comparison studies with 7760A. Method 3010A consistently demonstrated improved accuracy and precision over Method 7760A in the matrices tested (reagent water, surface water and TCLP leachate) up to a concentration of 1 ppm silver.

17.1.3. Modifications Specific to Method 3020A

17.1.3.1. Section 11.14.3 of this SOP requires the sample be reduced to a volume of 15 - 20 mL. Section 7.2 of Method 3010A states the volume should be reduced to 3 mL but also states that no portion of the bottom of the beaker should go dry. The SOP required volume is a closer approximation of the volume required to provide an adequate covering of the beaker so as to prevent the loss of critical analytes through volatilization.

17.1.4. Modifications Specific to Method 7060A/7740

17.1.4.1. Methods 7060A and 7740A incorporate the use of a two step dilution to accommodate the addition of a nickel nitrate modifier. This SOP performs the dilution directly in one step and omits the addition of the modifier. The modifier is added automatically at the instrument by direct injection into the furnace.

17.1.5. Modifications Specific to MCAWW Methods

It was determined by technical review that several of the MCAWW methods were equivalent to the SW-846 methods and therefore were combined under the scope of this SOP as described in Section 11.0. The nature of the differences were deemed insignificant in regards to the amount of acid added and the evaporative volume based on the flexibility allowed by the methods (i.e., add additional acid as required) and the subjective wording of the methods (i.e., evaporate to near dryness vs. an exact volume).

17.2. Modifications from previous SOP

17.2.1. Added ICP/MS to the digestion procedures.

17.3. Facility Specific SOPs

Each facility shall attach a list of facility specific SOPs or approved attachments (if applicable) which are required to implement this SOP or which are used in conjunction with this SOP. If no facility specific SOPs or amendments are to be attached, a statement must be attached specifying that there are none. Refer to the Appendices for any facility specific information required to support this SOP.

17.4. Documentation and Record Management

The preparation benchsheet should, at a minimum, include the following information:

- Preparation date, analyst name, matrix, prep type (ICP or GFAA), SOP reference.
- Sample ID; initial weight/volume and final weight/volume.
- Standards Documentation (source, lot, prep date, volume added).
- Analyst Signature.
- Reviewer's Signature and date.

Figure 1. Method 3005A / Method 200.7 Section 9.4 (Section 11.12)

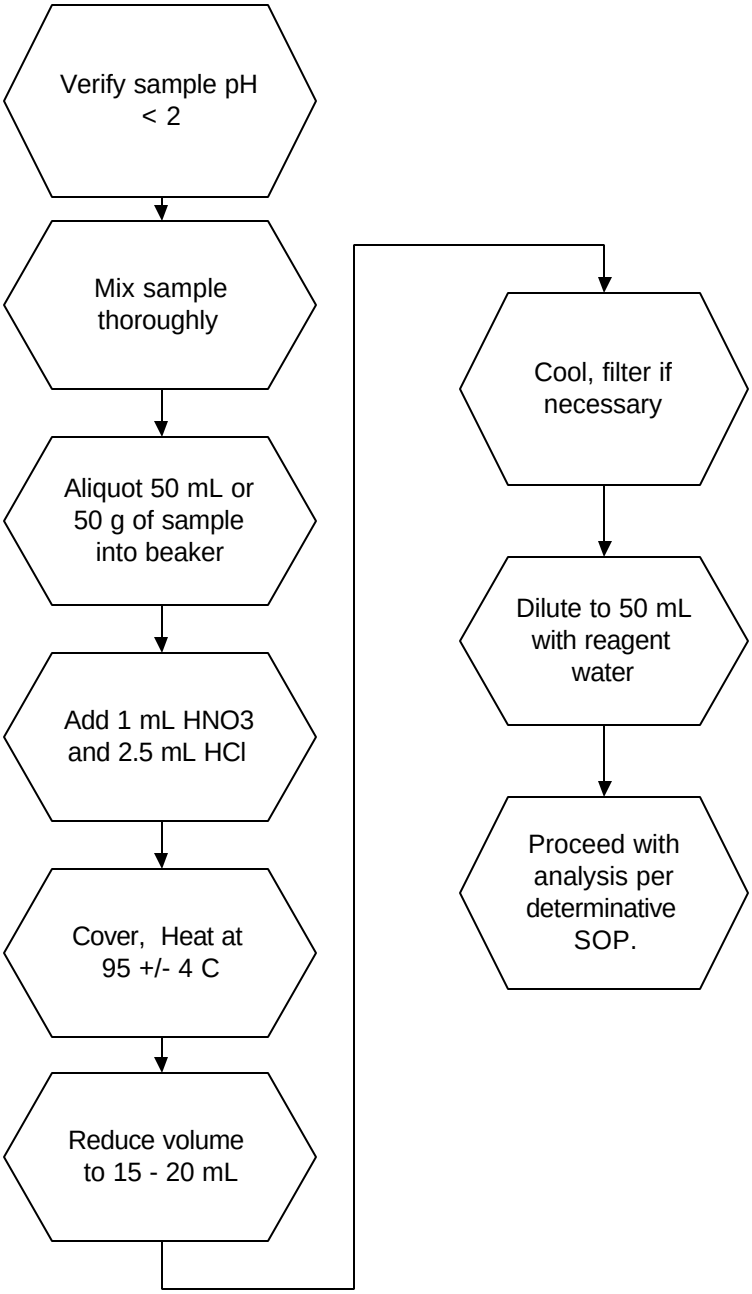


Figure 2. Method 3010A / Method 200.7 Section 9.3 (Section 11.13)

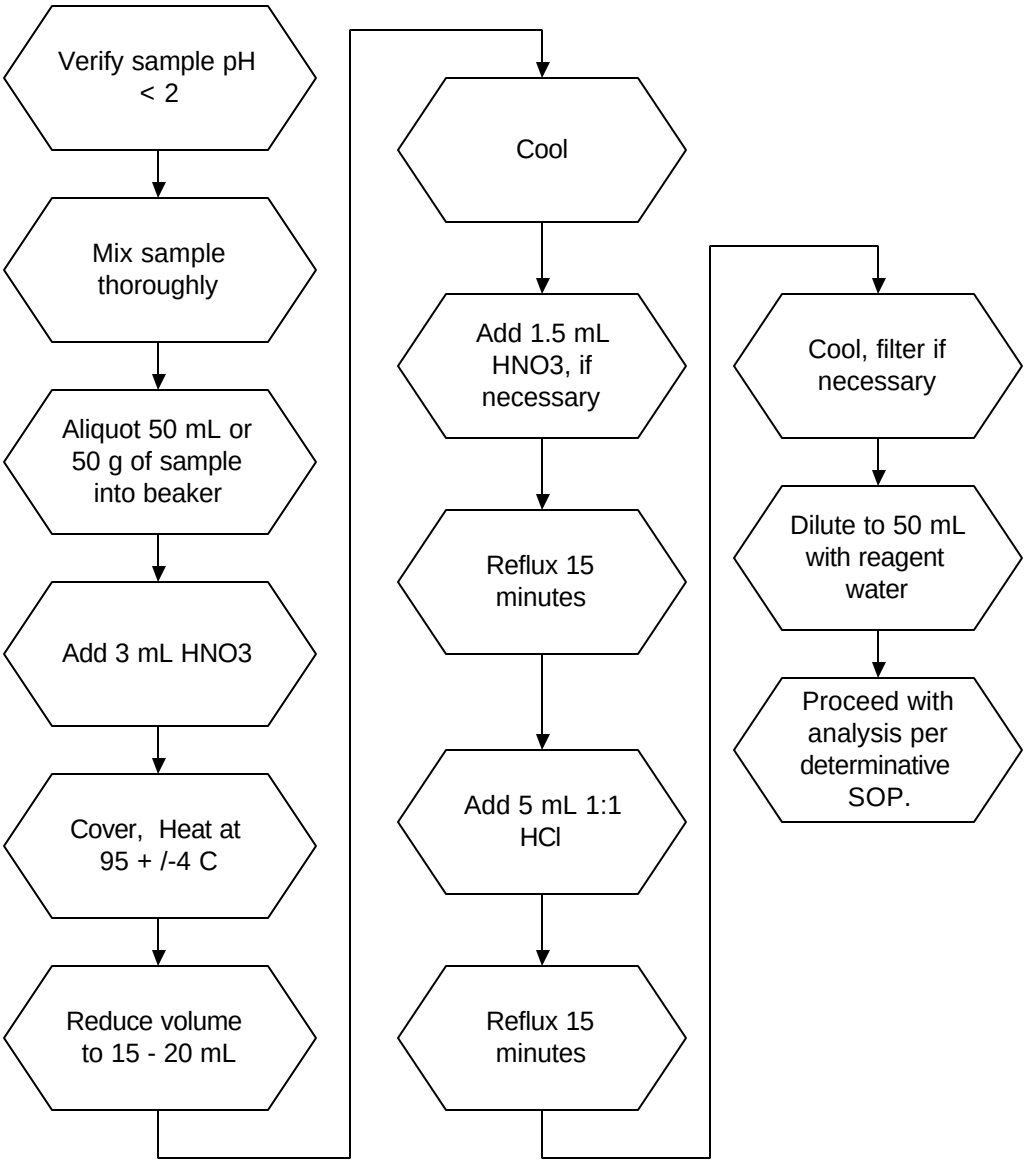


Figure 3. Method 3020A / Method 200.0 Section 4.1.3 (Section 11.14)

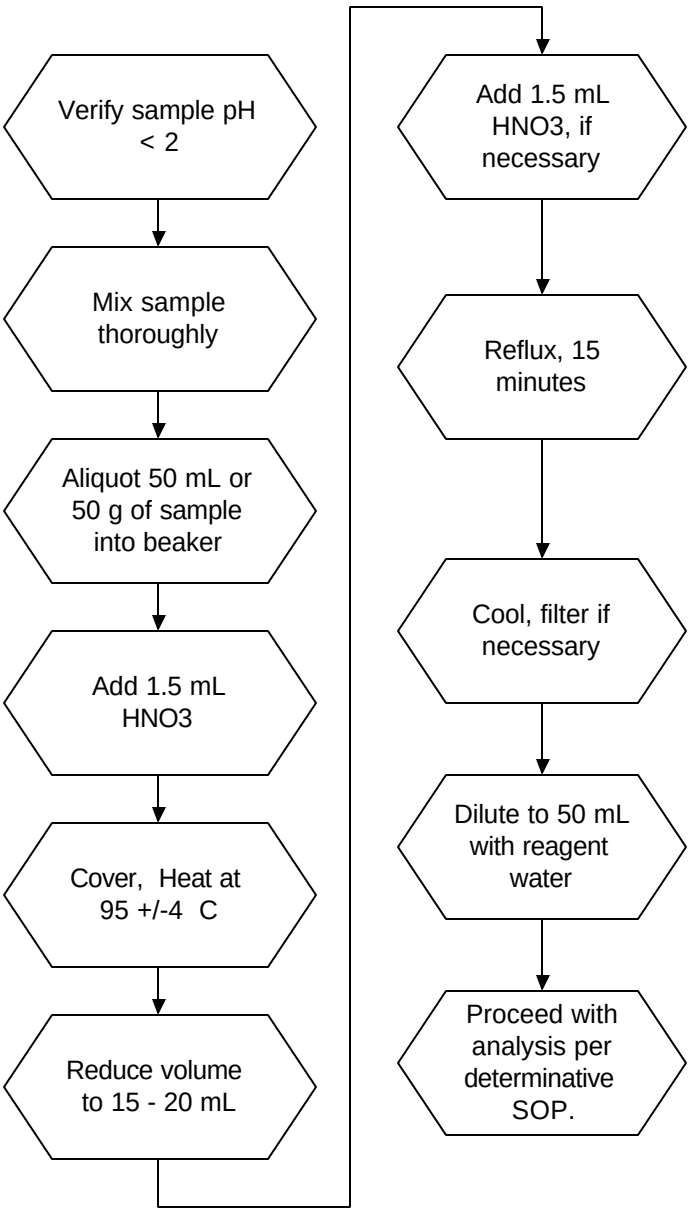


Figure 4. Method 7060A/7740A and Method 206.2/270.2 (Section 11.15)

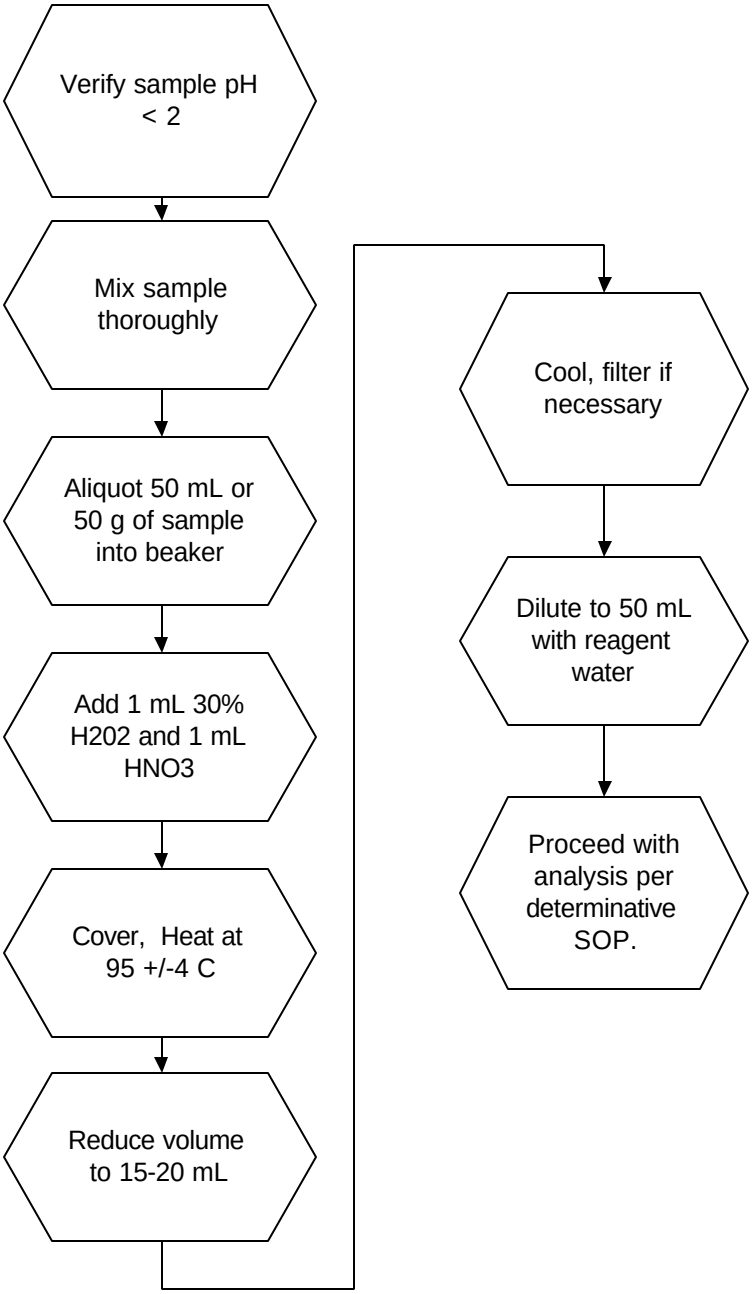


Figure 5. Method 200.0 Section 4.1.4 (Section 11.16)

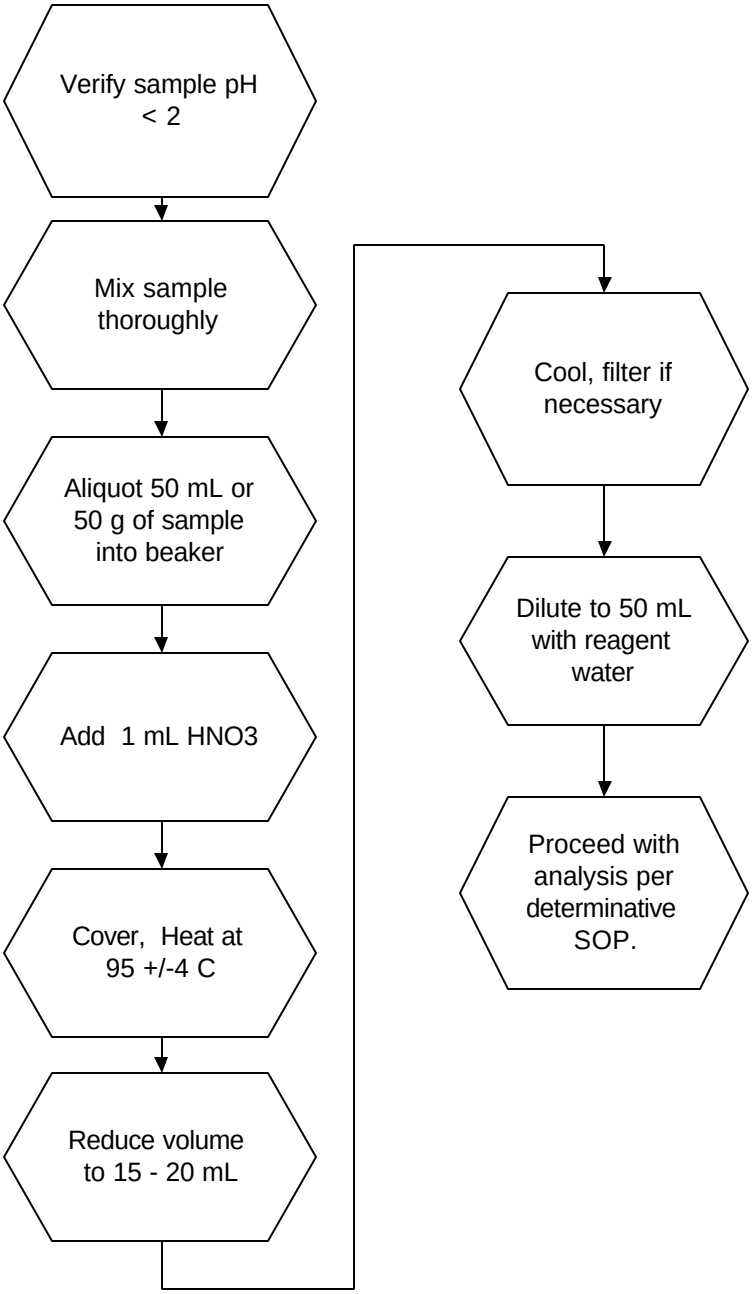
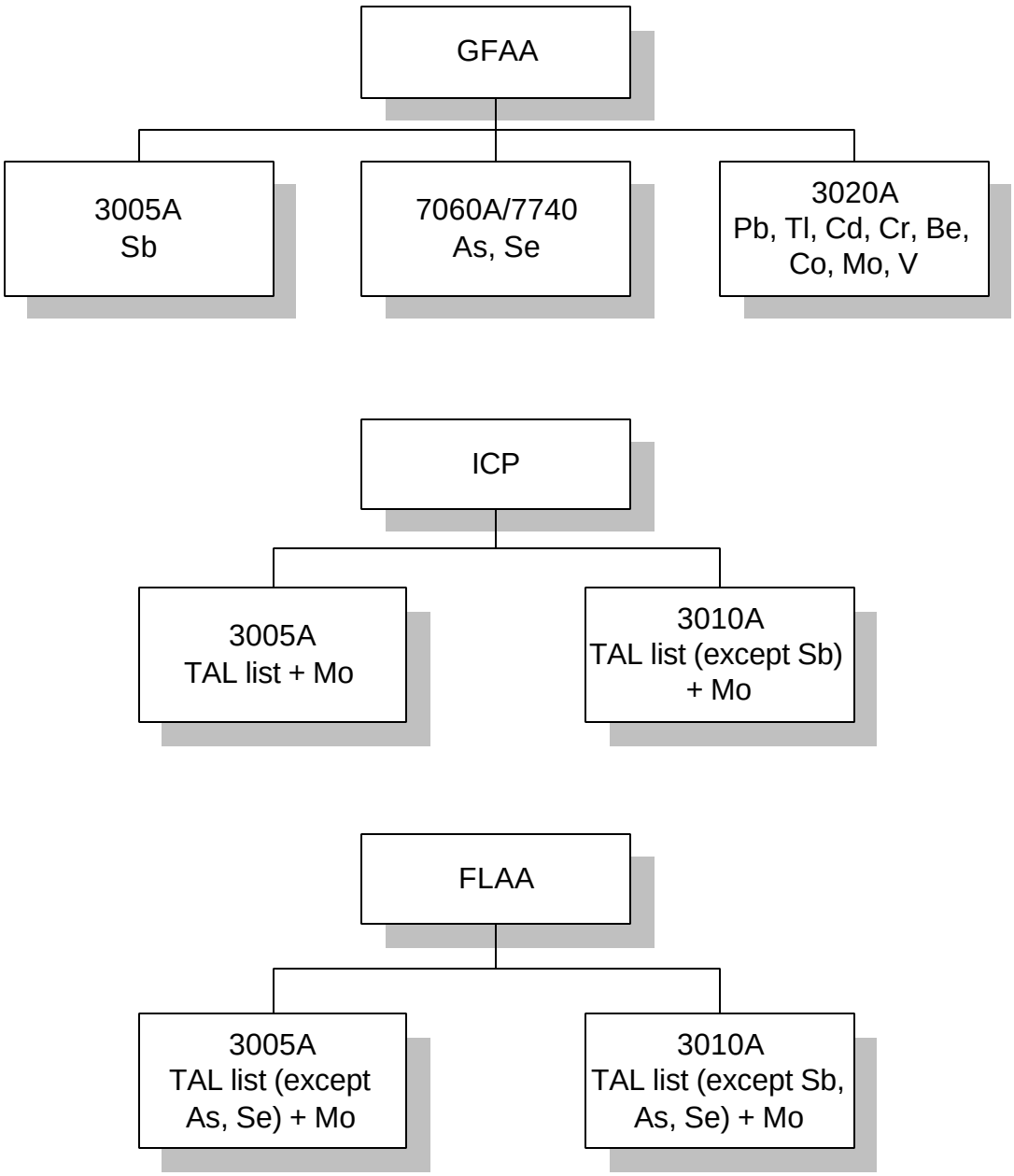
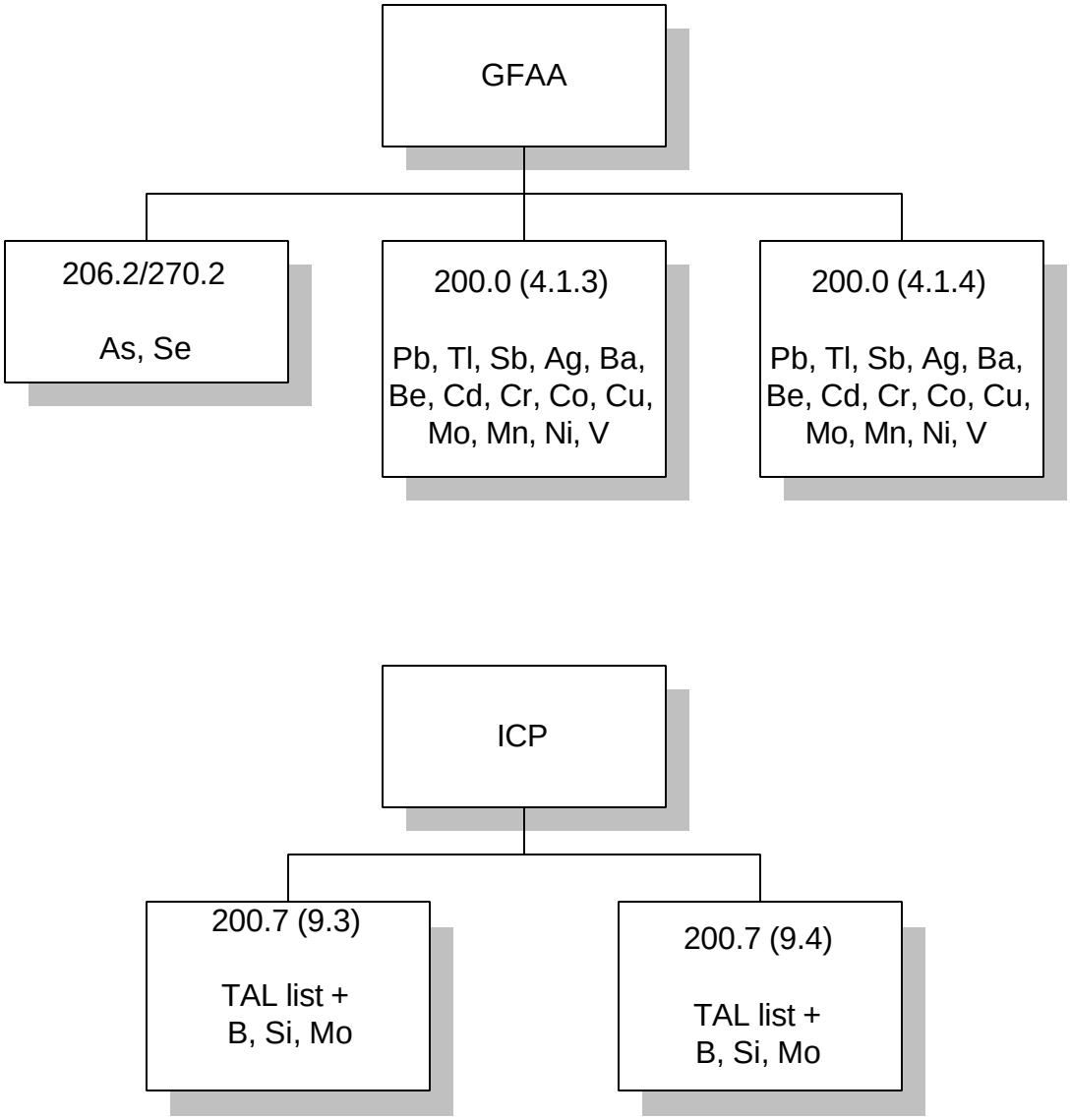


Figure 6. Overview of SW846 Aqueous Preparation Methods by Determinative Method



TAL list: Al, Sb, As, Ba, Be, Cd, Ca, Cr, Co, Cu, Fe, Pb, Mg, Mn, Ni, K, Se, Ag, Na, Tl, V, Zn

Figure 7. Overview of MCAWW Aqueous Preparation Methods by Determinative Technique



TAL list: Al, Sb, As, Ba, Be, Cd, Ca, Cr, Co, Cu, Fe, Pb, Mg, Mn, Ni, K, Se, Ag, Na, Tl, V, Zn

APPENDIX A

TABLES

TABLE I. Approved Preparation Method Analytes - SW846

ELEMENT	Symbol	CAS Number	3005A	3010A	3020A	7060A 7740
Aluminum	Al	7429-90-5	X	X		
Antimony	Sb	7440-36-0	X			
Arsenic	As	7440-38-2	X	X		X
Barium	Ba	7440-39-3	X	X		
Beryllium	Be	7440-41-7	X	X	X	
Cadmium	Cd	7440-43-9	X	X	X	
Calcium	Ca	7440-70-2	X	X		
Chromium	Cr	7440-47-3	X	X	X	
Cobalt	Co	7440-48-4	X	X	X	
Copper	Cu	7440-50-8	X	X		
Iron	Fe	7439-89-6	X	X		
Lead	Pb	7439-92-1	X	X	X	
Magnesium	Mg	7439-95-4	X	X		
Manganese	Mn	7439-96-5	X	X		
Molybdenum	Mo	7439-98-7	X	X	X	
Nickel	Ni	7440-02-0	X	X		
Potassium	K	7440-09-7	X	X		
Selenium	Se	7782-49-2	X	X		X
Silver	Ag	7440-22-4	X	X		
Sodium	Na	7440-23-5	X	X		
Thallium	Tl	7440-28-0	X	X	X	
Vanadium	V	7440-62-2	X	X	X	
Zinc	Zn	7440-66-6	X	X		

X - Designates that the preparation method is approved for an element

Note: Additional elements may be analyzed following digestion by these protocols provided the method performance criteria specified in Section 13.0 of the SOP are met.

TABLE II. Approved Preparation Method Analytes - NPDES

ELEMENT	Symbol	CAS Number	200.7 (9.4)	200.7 (9.3)	200.0 (4.1.4)	200.0 (4.1.3)	206.2 270.2
Aluminum	Al	7429-90-5	X	X			
Antimony	Sb	7440-36-0	X	X	X	X	
Arsenic	As	7440-38-2	X	X			X
Boron	B	7440-42-8	X	X			
Barium	Ba	7440-39-3	X	X	X	X	
Beryllium	Be	7440-41-7	X	X	X	X	
Cadmium	Cd	7440-43-9	X	X	X	X	
Calcium	Ca	7440-70-2	X	X			
Chromium	Cr	7440-47-3	X	X	X	X	
Cobalt	Co	7440-48-4	X	X	X	X	
Copper	Cu	7440-50-8	X	X	X	X	
Iron	Fe	7439-89-6	X	X	X	X	
Lead	Pb	7439-92-1	X	X	X	X	
Magnesium	Mg	7439-95-4	X	X			
Manganese	Mn	7439-96-5	X	X	X	X	
Molybdenum	Mo	7439-98-7	X	X	X	X	
Nickel	Ni	7440-02-0	X	X	X	X	
Potassium	K	7440-09-7	X	X			
Selenium	Se	7782-49-2	X	X			X
Silicon	Si	7631-86-9	X	X			
Silver	Ag	7440-22-4	X	X	X	X	
Sodium	Na	7440-23-5	X	X			
Thallium	Tl	7440-28-0	X	X	X	X	
Vanadium	V	7440-62-2	X	X	X	X	
Zinc	Zn	7440-66-6	X	X			

X - Designates that the preparation method is approved for an element

Note: Additional elements may be analyzed following digestion by these protocols provided the method performance criteria specified in Section 13.0 of the SOP are met.

TABLE III. ICP and FLAA Matrix Spike and Aqueous Laboratory Control Sample Levels

ELEMENT	Working LCS/MS Standard (mg/L)	Aqueous LCS/ MS Level * (ug/l)
Aluminum	100	2000
Antimony	25	500
Arsenic	100	2000
Barium	100	2000
Beryllium	2.5	50
Cadmium	2.5	50
Calcium	2500	50000
Chromium	10	200
Cobalt	25	500
Copper	12.5	250
Iron	50	1000
Lead	50	500
Magnesium	2500	50000
Manganese	25	500
Molybdenum	50	1000
Nickel	25	500
Phosphorous	500	10000
Potassium	2500	50000
Selenium	100	2000
Silver	2.5	50
Sodium	2500	50000
Thallium	100	2000
Vanadium	25	500
Zinc	25	500
Boron	50	1000
Tin	100	2000
Titanium	50	1000

* Levels shown indicate the spike concentration in the final digestate of the aqueous LCS or matrix spike based on the addition of 1.0 mL working spike (7.3) to 50 mL of sample.

TABLE IV. GFAA Matrix Spike and Aqueous LCS Spike Levels

ELEMENT	Stock LCS/MS Standard (mg/L)	Working LCS/MS Standard (ug/L)	Aqueous LCS/ MS Level * (ug/l)
Arsenic	400	2000	40
Selenium	400	2000	40
Lead	400	2000	40
Thallium	400	2000	40
Antimony	400	2000	40
Cadmium	40	200	4
Chromium	100	500	10
Silver	50	250	5

* Levels shown indicate the spike concentration in the final digestate of the aqueous LCS or matrix spike based on the addition of 1.0 mL working spike (7.4) to 50 mL of sample.

TABLE V. TCLP Reporting Limits, Regulatory Limits and Matrix Spike Levels

ELEMENT	RL (ug/L)	Regulatory Limit (ug/L)	Spike Level (ug/L)*
Arsenic	500	5000	5000
Barium	10000	100000	50000
Cadmium	100	1000	1000
Chromium	500	5000	5000
Lead	500	5000	5000
Selenium	250	1000	1000
Silver	500	5000	1000

* Levels shown indicate the spike concentration in the final digestate of the aqueous LCS or matrix spike based on the addition of 0.5 mL working spike (7.4) to 50 mL of sample

TABLE VI. Summary of Quality Control Requirements

QC PARAMETER	FREQUENCY	ACCEPTANCE CRITERIA	CORRECTIVE ACTION
Method Blank	One per sample preparation batch of up to 20 samples.	Refer to determinative SOPs: NC-MT-0002 CORP-MT-0001 CORP-MT-0003	Redigest and reanalyze samples associated with the method blank.
Laboratory Control Sample (LCS)	One per sample preparation batch of up to 20 samples.	Refer to determinative SOPs: NC-MT-0002 CORP-MT-0001 CORP-MT-0003	Redigest and reanalyze all samples associated with the LCS.
Matrix Spike	One per sample preparation batch of up to 20 samples.	Refer to determinative SOPs: NC-MT-0002 CORP-MT-0001 CORP-MT-0003	Reprep not required unless preparation error suspected.
Matrix Spike Duplicate	See Matrix Spike	Refer to determinative SOPs: NC-MT-0002 CORP-MT-0001 CORP-MT-0003	See Corrective Action for Matrix Spike.

APPENDIX B

CONTAMINATION CONTROL GUIDELINES

APPENDIX B. CONTAMINATION CONTROL GUIDELINES

The following procedures are strongly recommended to prevent contamination:

All work areas used to prepare standards and spikes should be cleaned before and after each use.

All glassware should be washed with detergent and tap water and rinsed with 1:1 nitric acid followed by deionized water.

Proper laboratory housekeeping is essential in the reduction of contamination in the metals laboratory. All work areas must be kept scrupulously clean.

Powdered or Latex Gloves must not be used in the metals laboratory since the powder contains silica and zinc, as well as other metallic analytes. Only vinyl or nitrile gloves should be used in the metals laboratory.

Glassware should be periodically checked for cracks and etches and discarded if found. Etched glassware can cause cross contamination of any metallic analytes.

Autosampler trays should be covered to reduce the possibility of contamination. Trace levels of elements being analyzed in the samples can be easily contaminated by dust particles in the laboratory.

The following are helpful hints in the identification of the source of contaminants:

Reagents or standards can contain contaminants or be contaminated with the improper use of a pipette.

Improper cleaning of glassware can cause contamination.

Separate glassware if an unusually high sample is analyzed and soak with sulfuric acid prior to routine cleaning.

STL NORTH CANTON STANDARD OPERATING PROCEDURE

TITLE: GAS CHROMATOGRAPHIC ANALYSIS BASED ON METHOD 8000B, 8021B, 8081A, 8082, 8151A, 8310, 8141A, 8015B, and 615

(SUPERSEDES: Revision 5.6 Dated 05/25/01)

Prepared by:		10/9/03 Date
Approved by:	Technology Specialist	10/9/03 Date
Approved by:	Quality Assurance Manager	10/17/03 Date
Approved by:	Environmental Health and Safety	10/16/03 Date
Approved by:	Laboratory Director	10/16/03 Date
Approved by:	Technical Director	10/17/03 Date

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1. SCOPE AND APPLICATION

This SOP describes procedures for analysis of organic analytes by Gas Chromatography (GC). The procedures are based on SW-846 methodology and are applicable for measurements made to comply with the Resource Conservation and Recovery Act (RCRA). Individual analytes and methods are described in the appendices. Appendix G describes procedures for the analysis of petroleum hydrocarbons by SW-846 8015B methodology. Appendix H includes criteria for the analysis of non-halogenated organic compounds by Method 8015B, Direct Injection. Appendix I describes the analysis of Phillips 66 analytes by Method 8015B.

2. SUMMARY OF METHOD

In general, semivolatile analytes in aqueous samples are prepared for analysis using continuous or separatory funnel liquid / liquid extraction or solid phase extraction (SOP # CORP-OP-0001NCNC) Solid samples are prepared using sonication, Soxhlet or pressurized fluid extraction (SOP # CORP-OP-0001NC). Volatile analytes are prepared for analysis using purge and trap methodology (Appendix A).

After the initial preparation step, the sample is introduced to the GC and concentrations of target analytes are measured by the detector response within a defined retention time window, relative to the response to standard concentrations. Internal or external standardization procedures are used as specified in the method appendices.

3. DEFINITIONS

Definitions of terms used in this SOP may be found in the glossary of the STL North Canton Laboratory Quality Manual (LQM), current version.

4. INTERFERENCES

Contamination by carryover can occur when a low concentration sample is analyzed after a high concentration sample. In addition, some purge and trap autosamplers are susceptible to port specific contamination. Co-elution of target analytes with non-targets can occur, resulting in false positives or biased high results. In particular, this is a problem with non-selective detectors such as the Flame Ionization Detector (FID). See the appendices for interferences specific to individual tests and suggested corrective actions.

5. SAFETY

5.1. Employees must abide by the policies and procedures in the Corporate Safety Manual, Radiation Safety Manual and this document.

5.2. Eye protection that prevents splash, laboratory coat, and appropriate gloves must be worn while samples, standards, solvents, and reagents are being handled. Disposable gloves that have become contaminated will be removed and discarded; other gloves will be cleaned immediately. Refer to the STL North Canton Chemical Hygiene plan for a complete description of personal protection equipment. Latex, Nitrile and vinyl gloves all provide adequate protection against the methanol used in this method.

5.3. The following is a list of the materials used in this method, which have a serious or significant hazard rating. **NOTE: This list does not include all materials used in the method. The table contains a summary of the primary hazards listed in the MSDS for each of the materials listed in the table.** A complete list of materials used in the method can be found in the reagents and materials section.

Employees must review the information in the MSDS for each material before using it for the first time or when there are major changes to the MSDS.

Material	Hazards	Exposure Limit (2)	Signs and symptoms of exposure
Methanol	Flammable Poison Irritant	200 ppm-TWA	A slight irritant to the mucous membranes. Toxic effects exerted upon nervous system, particularly the optic nerve. Symptoms of overexposure may include headache, drowsiness and dizziness. Methyl alcohol is a defatting agent and may cause skin to become dry and cracked. Skin absorption can occur; symptoms may parallel inhalation exposure. Irritant to the eyes.
Acetone	Flammable	1000 ppm-TWA	Inhalation of vapors irritates the respiratory tract. May cause coughing, dizziness, dullness, and headache.
Hexane	Flammable Irritant	500 ppm-TWA	Inhalation of vapors irritates the respiratory tract. Overexposure may cause lightheadedness, nausea, headache, and blurred vision. Vapors may cause irritation to the skin and eyes.
Methylene Chloride	Carcinogen Irritant	25 ppm-TWA 125 ppm-STEL	Causes irritation to respiratory tract. Has a strong narcotic effect with symptoms of mental confusion, light-headedness, fatigue, nausea, vomiting and headache. Causes irritation, redness and pain to the skin and eyes. Prolonged contact can cause burns. Liquid degreases the skin. May be absorbed through skin.
Sulfuric Acid	Corrosive Oxidizer Dehydrator Poison Carcinogen	1 Mg/M3-TWA	Inhalation produces damaging effects on the mucous membranes and upper respiratory tract. Symptoms may include irritation of the nose and throat, and labored breathing. Symptoms of redness, pain, and severe burn can occur. Contact can cause blurred vision, redness, pain and severe tissue burns. Can cause blindness.

MTBE	Flammable Irritant	None established	Excessive exposure may cause irritation to the nose, throat, lungs, and respiratory tract. Central nervous system effects may include headache, dizziness, loss of balance and coordination.
THF	Flammable Irritant Possible Carcinogen	200 ppm TWA	Causes skin and eye irritation. Irritating to mucous membranes and upper respiratory tract.
Isooctane	Flammable Irritant	None Established	May cause eye, respiratory tract and skin irritation.
Hydrochloric Acid	Corrosive Poison	5 ppm-Ceiling	Inhalation of vapors can cause coughing, choking, inflammation of the nose, throat, and upper respiratory tract, and in severe cases, pulmonary edema, circulatory failure, and death. Can cause redness, pain, and severe skin burns. Vapors are irritating and may cause damage to the eyes. Contact may cause severe burns and permanent eye damage.
Sodium Bisulfate	Corrosive	None Listed	Contact may cause skin/eye burns. Inhalation can cause irritation of the respiratory tract with burning pain in the nose and throat, coughing, wheezing and shortness of breath. Causes chemical burns to the respiratory tract. May cause fatal spasms, inflammation or pulmonary/respiratory edema.
1 – Always add acid to water to prevent violent reactions.			
limit refers to the OSHA regulatory exposure limit.			

5.4. Opened containers of neat standards will be handled in a fume hood.

5.5. Sample extracts and standards, which are in a flammable solvent, shall be stored in an explosion-proof refrigerator.

5.6. When using hydrogen gas as a carrier, all precautions listed in the CSM shall be observed.

5.7. Standard preparation and dilution shall be performed inside an operating fume hood.

5.8. The gas chromatograph contains zones that have elevated temperatures. The analyst needs to be aware of the locations of those zones, and must cool them to room temperature prior to working on them.

5.9. There are areas of high voltage in both the gas chromatograph and the mass spectrometer. Depending on the type of work involved, either turn the power to the instrument off, or disconnect it from its source of power.

6. EQUIPMENT AND SUPPLIES

6.1. An analytical system complete with a gas chromatograph is required. A data system capable of measuring peak area and/or height is required. Recommended equipment and supplies for individual methods are listed in each method appendix.

7. REAGENTS AND STANDARDS

7.1. Stock Standards

Stock standards are purchased as certified solutions or prepared from pure solutions. Stock standards for method 8021B are stored at -10 to -20°C. Other stock standard solutions are stored as recommended by the manufacturer. All stock standards must be protected from light. Stock standard solutions should be brought to room temperature before using.

Semivolatile stock standard solutions must be replaced after one year. Stock standards of gases must be replaced at least every week, unless the acceptability of the standard is demonstrated (Less than 20% drift from the initial calibration is an acceptable demonstration). Other volatile stock standards must be replaced every 6 months or sooner if comparison with check standards prepared from an independent source indicates a problem.

7.1.1. Expiration times for all standards are measured from the time the standard is prepared or from the time that the standard ampoule is opened, if the standard is supplied in a sealed ampoule. If a vendor-supplied standard has an earlier expiration date then that date is used.

7.2. Calibration Standards

7.2.1. Volatile Calibration Standards

The procedure for preparation of volatile standards is given in Appendix A.

7.2.2. Semivolatile Calibration Standards

Semivolatile calibration standards are prepared as dilutions of the stock standards. Surrogates and internal standards are used as specified in the method appendices. Semivolatile calibration solutions must be refrigerated at ≤6°C and protected from light. The standards must be replaced at least every six months or sooner if comparison with check standards indicates a problem.

7.3. Gases for carrier and make-up: Hydrogen, Helium, Nitrogen, Argon/Methane.

7.4. Quality control (QC) Standards

QC standards (matrix spiking and LCS standards) are prepared and stored in the same way as calibration standards. They must be made from a stock independent from the calibration standards.

8. SAMPLE PRESERVATION AND STORAGE

Semivolatile extracts must be refrigerated at ≤6°C and analyzed within 40 days of the end of the extraction. Volatile sample storage conditions and holding times are given in Appendix A.

9. QUALITY CONTROL

9.1. Initial Demonstration of Capability

9.1.1. For the standard analyte list, the initial demonstration and method detection limit (MDL) studies described in Section 13 must be acceptable before analysis of samples may begin.

9.1.2. For non-standard analytes, a MDL study must be performed and calibration curve generated before analyzing any samples, unless lesser requirements are previously agreed to with the client. In any event the minimum initial demonstration required is analysis of an extracted standard at the reporting limit and a single point calibration.

9.2. Batch Definition

Batches are defined at the sample preparation stage. Batches should be kept together through the whole analytical process as far as possible, but it is not mandatory to analyze prepared extracts on the same instrument or in the same sequence. Refer to the STL North Canton QC Program document (QA-003) for further details of the batch definition.

9.2.1. Quality Control Batch

The batch is a set of up to 20 samples of the same matrix processed using the same procedures and reagents within the same time period. The Quality Control batch must contain a matrix spike / spike duplicate (MS/MSD), a Laboratory Control Sample (LCS), and a method blank. Laboratory generated QC samples (Blank, LCS, MS/MSD) do not count towards the maximum 20 samples in a batch. Field QC samples are included in the batch count. In some cases, at client request, the MS/MSD may be replaced with a matrix spike and sample duplicate. If insufficient sample is available for an MS/MSD a LCSD may be substituted.

9.3. Control Limits

In-house historical control limits must be determined for surrogates, matrix spikes, and laboratory control samples (LCS). These limits must be determined at least annually. The recovery limits are mean recovery +/- 3 standard deviations, unless that limit is tighter than the calibration criteria, in which case limits may be widened. Refer to policy QA-003 for more details.

9.3.1. These limits do not apply to dilutions (except for tests without a separate extraction), but surrogate and matrix spike recoveries will be reported unless the dilution is more than 5X.

9.3.2. All surrogate, LCS, and MS recoveries (except for dilutions) must be entered into QuantIMS (when available) or other database so that accurate historical control limits can be generated. For tests without a separate extraction, surrogates and matrix spikes will be reported for all dilutions.

9.3.3. Refer to the QC Program document (QA-003) for further details of control limits.

9.4. Surrogates

All methods must use surrogates to the extent possible. Surrogate recoveries in samples and QC samples must be assessed to ensure that recoveries are within established limits. If any surrogates are outside limits, the following corrective actions must take place (except for dilutions):

- Check all calculations for error.
- Ensure that instrument performance is acceptable.
- Recalculate the data and/or reanalyze the extract if either of the above checks reveal a problem.
- Reprepare and reanalyze the sample or flag the data as “Estimated Concentration” if neither of the above resolves the problem. Repreparation is not necessary is there is obvious chromatographic interference.
- The decision to reanalyze or flag the data should be made in consultation with the client. It is only necessary to reprepare / reanalyze a sample once to demonstrate that poor surrogate recovery is due to matrix effect, unless the analyst believes that the repeated out of control results are not due to matrix effect.

9.4.1. If dual column analysis is used the choice of which result to report is made in the same way as for samples (Section 12.1.2) unless one column is out of control, in which case the in-control result is reported.

9.4.2. If the surrogates are out of control for the sample, matrix spike, and matrix spike duplicate, then matrix effect has been demonstrated for that sample and repreparation is not necessary. If the sample is out of control and the MS and/or MSD is in control, then repreparation or flagging of the data is required.

9.4.3. Refer to the STL North Canton QC Program document (QA-003) for further details of the corrective actions.

9.5. Method Blanks

For each batch of samples, analyze a method blank. The method blank consists of reagent water for aqueous semivolatile samples, and sodium sulfate for semivolatile soils tests (Refer to SOP No. CORP-OP-0001NCNC for details). For low level volatiles, the method blank consists of reagent water. For medium level volatiles, the method blank consists of methanol as described in Appendix A. Surrogates are added and the method blank is carried through the entire analytical procedure. The method blank must not contain any analyte of interest at or above the reporting limit (except common laboratory contaminants, see below) or at or above 5% of the measured concentration of that analyte in the associated samples, whichever is higher.

If the analyte is a common laboratory contaminant (methylene chloride, acetone, 2-butanone, phthalate esters) the data may be reported with qualifiers if the concentration of the analyte is less than five times the reporting limit. Such action must be taken in consultation with the client.

Re-extraction and reanalysis of samples associated with an unacceptable method blank is required when reportable concentrations are determined in the samples.

If there is no target analyte greater than the RL in the samples associated with an unacceptable method blank, the data may be reported with qualifiers. Such action should be taken in consultation with the client.

9.5.1. Refer to the STL North Canton QC Program document (QA-003) for further details of the corrective actions.

9.6. Instrument Blanks

9.6.1. An instrument blank must be analyzed during any 12-hour period of analysis that does not contain a method blank.

9.6.2. An instrument blank consists of the appropriate solvent with internal standards added. If internal standards are not used the surrogates should be added.

9.6.3. Control criteria are the same as for the method blank, except that only reanalysis of affected samples would be required, not re-extraction.

9.7. Laboratory Control Samples (LCS)

For each batch of samples, analyze a LCS. The LCS contains a representative subset of the analytes of interest, and must contain the same analytes as the matrix spike. The LCS may also contain the full set of analytes with a subset of control analytes. If any control analyte or surrogate is outside established control limits, the system is out of control and corrective action must occur. Corrective action will normally be repreparation and reanalysis of the batch; however, if the matrix spike and matrix spike duplicate are within limits; the batch may be acceptable.

9.7.1. Refer to the STL North Canton QC Program document (QA-003) for further details of the corrective action.

9.7.2. If dual column analysis is used the choice of which result to report is made in the same way as for samples (Section 12.1.2) unless one column is out of control, in which case the in control result is reported.

9.7.3. LCS compound lists are included in the appendices.

9.8. Matrix Spikes

For each QC batch, analyze a matrix spike and matrix spike duplicate. Spiking compounds and levels are given in the appendices. Compare the percent recovery and relative percent difference (RPD) to those in the laboratory specific historically generated limits.

- If any individual recovery or RPD falls outside the acceptable range, corrective action must occur. The initial corrective action will be to check the recovery of that analyte in the Laboratory Control Sample (LCS). Generally, if the recovery of the analyte in the LCS is within limits, then the laboratory operation is in control and analysis may proceed.
- If the recovery for any component is outside QC limits for both the Matrix spike / spike duplicate and the LCS, the laboratory is out of control and corrective action must be taken. Corrective action will normally include repreparation and reanalysis of the batch.
- If a MS/MSD is not possible due to limited sample, then a LCS duplicate should be analyzed.
- The matrix spike / duplicate must be analyzed at the same dilution as the unspiked sample, unless the matrix spike components would then be above the calibration range.

9.8.1. If dual column analysis is used the choice of which result to report is made in the same way as for samples (Section 12.1.2) unless one column is out of control, in which case the in control result is reported.

9.9. Quality Assurance Summaries

Certain clients may require specific project or program QC that may supersede these method requirements. Quality Assurance Summaries should be developed to address these requirements.

9.10. STL North Canton QC Program

Further details of QC and corrective action guidelines are presented in the STL QC Program document (QA-003). Refer to this document if in doubt regarding corrective actions.

10. CALIBRATION AND STANDARDIZATION

Internal or external calibration may be used. Internal calibration is recommended unless the sample matrix is likely to interfere with the quantitation of the internal standard. In either event prepare standards containing each analyte of interest at a minimum of five concentration levels. The low level standard should be at or below the reporting limit. The other standards define the working range of the detector. Recommended calibration levels are given in the appendices.

10.1. A new calibration curve must be generated after major changes to the system or when the continuing calibration criteria cannot be met. Major changes include new columns, changing PID lamps or FID jets or replacing the ECD detector. A new calibration is not required after clipping the column, replacing the septum or syringe, or other minor maintenance.

10.2. With the exception of 10.3 below, it is NOT acceptable to remove points from a calibration curve for the purpose of meeting criteria, unless the points are the highest or lowest on the curve AND the reporting limit and/or linear range is adjusted accordingly. In any event, at least 5 points must be included in the calibration curve. Quadratic (second order) calibrations require at least six points. Third order calibrations require at least seven points.

10.3. A level may be removed from the calibration if the reason can be clearly documented, for example a broken vial or no purge run. A minimum of five levels must remain in the calibration. The documentation must be retained with the initial calibration. Alternatively, if the analyst believes that a point on the curve is inaccurate, the point may be reanalyzed and the reanalysis used for the calibration. All initial calibration points must be analyzed without any changes to instrument conditions, and all points must be analyzed within 24 hours.

10.4. External standard calibration

Quantitation by the external standard method assumes a proportional relationship between the calibration run and the analyte in the sample. To use this approach, introduce each calibration standard into the GC using the technique that will be used for samples. The ratio of the peak height or area response to the mass or concentration injected may be used to prepare a calibration curve.

$$Calibration\ Factor\,(CF) = \frac{Area\ or\ Height\ of\ Peak}{Mass\ Injected\,(ng)}$$

Some data systems may use the inverse of this formula. This is acceptable so long as the same formula is used for standards and samples. It is also possible to use the concentration of the standard rather than the mass injected. (This would require changes in the equations used to calculate the sample concentrations). Use of peak area or height must be consistent. However, if matrix interferences would make quantitation using peak area inaccurate for a particular sample, then peak height may be used as a substitute.

10.5. Internal standard calibration

10.5.1. The internal standard approach assumes that variations in instrument sensitivity, amount injected etc. can be corrected by determining the ratio of the response of the analyte to the response of an internal standard that has been added to the extract. To use this approach, select one or more internal standard(s) that are similar in analytical behavior to the compounds of interest. Recommended internal standards are given in the appendices. The analyst must demonstrate that the measurement of the internal standard is not affected by method or matrix interferences. If the sample matrix interferes with quantitation of the internal standard, then the external standard approach must be used instead. In this event use the response factors from the previous continuing calibration to quantitate the analytes in the sample with the interference (applies only to the sample with the interference).

10.5.2. Introduce each calibration standard into the GC using the technique that will be used for samples. Response factors (RF) for each compound are calculated as follows:

$$RF = \frac{A_s \times C_{is}}{A_{is} \times C_s}$$

Where:

A_s = Response for the analyte to be measured
A_{is} = Response for the internal standard
C_{is} = Concentration of internal standard
C_s = Concentration of the analyte to be determined in the standard

10.6. Calibration curve fits

Average response factor, linear regression, or quadratic curves may be used to fit the data. Average response factor may be used if the average % RSD of the response factors or calibration factors of all the analytes in the calibration standard taken together is ≤ 20%. The average %RSD is calculated by summing the RSD value for each analyte and dividing by the total number of analytes.

10.6.1. In general, for environmental analysis, average response factors are the most appropriate calibration model. Linear or curved regression fits should only be used if the analyst has reason to believe that the average RF model does not fit the normal concentration/response behavior of the detector.

10.6.2. Average response factor

The average response factor may be used if the average percent relative standard deviation (%RSD) of all the response factors taken together is ≤ 20%.

The equation for average response factor is:

$$\textit{Average response factor} = \overline{RF} = \frac{\sum_{i=1}^{n} RF_i}{n}$$

Where: n = Number of calibration levels

$\sum_{i=1}^{n} RF_i$ = Sum of response factors for each calibration level

10.6.3. Linear regression

The linear fit uses the following functions:

10.6.3.1. External Standard

$$y = ax + b$$

or

$$x = \frac{(y - b)}{a}$$

Where: y = Instrument response
x = Concentration
a = Slope
b = Intercept

10.6.3.2. Internal Standard

$$C_s = \frac{\left[\frac{A_s C_{is}}{A_{is}} - b\right]}{a}$$

Where: C_s = Concentration in the sample
A_s = Area of target peak in the sample
A_{is} = Area of internal standard in the sample
C_{is} = Concentration of the internal standard

10.6.4. Quadratic curve

The quadratic curve uses the following functions:

10.6.4.1. External standard

$$y = ax + cx^2 + b$$

Where c is the curvature

10.6.4.2. Internal Standard

$$y = a\left(\frac{A_s \times C_{is}}{A_{is}}\right) + c\left(\frac{A_s \times C_{is}}{A_{is}}\right)^2 + b$$

10.7. Evaluation of calibration curves

10.7.1. The percent relative standard error (%RSE) from the calibration curve is used to evaluate the initial calibration. This provides a measure of how much error is associated with using the calibration curve for quantitation.

10.7.2. The least squares regression line is calculated and used to calculate the predicted concentration for each level. The percent relative standard error is calculated as follows:

$$\%\ RSE = 100\% \times \sqrt{\frac{\sum_{i=1}^{N}\left[\frac{C_i - PC_i}{C_i}\right]^2}{(N-P)}}$$

Where:
N = Number of points in the curve
P = Number of parameters in the curve (= 1 for average response factor, 2 for linear, 3 for quadratic)
C_i = True concentration for level i
PC_i = Predicted concentration for level i

Note that when average response factors are used, %RSE is equivalent to %RSD.

10.8. The following requirements must be met for any calibration to be used:

- Response must increase with increasing concentration.
- If a curve is used, the intercept of the curve at zero response must be less than ± the reporting limit for the analyte.
- The average Relative Standard Error (RSD for average response factors) of the calibration points from the curve used must be ≤ 20%.
- Some data systems will not measure the %RSE from a linear or quadratic fit. For the linear case, the correlation coefficient may be used as an alternative to the %RSE, and must be greater than or equal to 0.990. For the quadratic case the Coefficient of Determination may be used, and must be greater or equal to 0.990.

Note: The Relative Standard Error (RSE) is superior to the Correlation Coefficient (r) and Coefficient of Determination (r^2) for testing the fit of a set of calibration points to a line. The lower points on a curve have little effect on r. As a result a curve may have a very good correlation coefficient (>0.995), while also having > 100% error at the low point.

10.9. Weighting of data points

10.9.1. In linear and quadratic calibration fits, the points at the lower end of the calibration curve have less absolute variance than points at the high concentration end of the curve. This can cause severe errors in quantitation at the low end of the calibration. However, in environmental analysis, accuracy at the low end of the curve is very important. For this reason it is preferable to increase the weighting of the lower concentration points. $1/\text{Concentration}^2$ weighting (often called $1/X^2$ weighting) will improve accuracy at the low end of the curve and should be used if the data system has this capability.

10.10. Non-standard analytes are sometimes requested. For these analytes, it may be acceptable to analyze a single standard at the reporting limit with each continuing calibration rather than a five point initial calibration. This action must be with client approval. If the analyte is detected in any of the samples, a five point initial calibration must be generated and the sample(s) reanalyzed for quantitation.

10.11. Calibration Verification

10.11.1. 12 hour Calibration

The working calibration curve or RF must be verified by the analysis of a mid point calibration standard at the beginning, after every 12 hours, and at the end of the analysis sequence. The center of each retention time window is updated with each 12-hour calibration or calibration verification.

10.11.2. Calibration Verification

It may be appropriate to analyze a mid point standard more frequently than every 12 hours. If these calibration verification standards are analyzed, requirements are the same as the 12-hour calibration with the exception that retention times are not updated.

10.11.3. Any individual compounds with %D < 15% meet the calibration criteria. The calibration verification is also acceptable if the average of the %D for all the analytes is < 15%. This average is calculated by summing the entire absolute %D results in the calibration (including surrogates) and dividing by the number of analytes. Any analyte that is reportable as found must have a % difference of < 15% in the calibration verification or 12 hour calibration, on the column used for quantitation. Refer to section 12.1.2 for which result to report.

10.11.4. It is not necessary to run a calibration verification standard at the beginning of the sequence if samples are analyzed immediately after the completion of the initial calibration.

10.11.5. Samples quantitated by external standard methods must be bracketed by calibration verification standards that meet the criteria listed above. The bracketing standards on the column used for calibration must meet the same criteria as the opening standards. Bracketing is not necessary for internal standard methods.

10.11.6. If the analyst notes that a CCV has failed and can document the reason for failure (e.g. no purge, broken vial, carryover from the previous sample etc.) then a second CCV may be analyzed without any adjustments to the instrument. If this CCV meets criteria then the preceding samples have been successfully bracketed. If adjustments to the instrument are performed before the repeat CCV then the proceeding samples have not been successfully bracketed but analysis may continue.

10.11.7. In general, it is not advisable to analyze repeat CCVs on unattended runs. If repeat CCVs are analyzed then the first will serve as the bracketing standard for the preceding samples and the last will serve as the CCV for the following samples.

10.11.8. If highly contaminated samples are expected it is acceptable to analyze blanks or primers at any point in the run.

10.11.9. % Difference calculation

% Difference for internal and external methods is calculated as follows

Internal Standard:

$$\%D = \frac{RF_c - \overline{RF}}{\overline{RF}} \times 100$$

External standard:

$$\%D = \frac{CF_c - \overline{CF}}{\overline{CF}} \times 100$$

Where RF_c and CF_c are the response and calibration factors from the continuing calibration

$\overline{RF}$ and $\overline{CF}$ are the average response and calibration factors from the initial calibration

10.11.10. % Drift calculation

% Drift is used for comparing the continuing calibration to a linear or quadratic curve. The criteria for % drift are the same as for % difference

$$\%\ Drift = \frac{Calculated\ Conc. - Theoretical\ Conc.}{Theoretical\ Conc.} \times 100\%$$

10.11.11. Corrective Actions for Continuing Calibration

If the overall average %D of all analytes is greater than ± 15% corrective action must be taken. This may include clipping the column, changing the liner or other minor instrument adjustments, followed by reanalyzing the standard. If the overall average %D still varies by more than ± 15%, a new calibration curve must be prepared.

10.11.12. Corrective Action for Samples

For internal standard methods, any samples injected after a standard not meeting the calibration criteria must be re-injected.

For external standard methods, any samples injected after the last good continuing calibration standard must be re-injected.

If the average %D for all the analytes in the calibration is over 15%, but all of the analytes requested for a particular sample have %D ≤ 15%, then the analysis is acceptable for that sample.

11. PROCEDURE

11.1. Extraction

Extraction procedures are referenced in the appendices.

11.2. Cleanup

Cleanup procedures are referenced in the appendices.

11.3. Gas Chromatography

Chromatographic conditions for individual methods are presented in the appendices.

11.4. Sample Introduction

In general, volatiles analytes are introduced using purge and trap as described in Appendix A. Semivolatile analytes are introduced by direct injection of the extract. Samples, standards, and QC must be introduced using the same procedure.

11.5. Analytical Sequence

An analytical sequence starts with an initial calibration or a daily calibration. Refer to the individual method appendices for method specific details of daily calibrations and analytical sequences.

11.5.1. The daily calibration includes analysis of standards containing all single response analytes and updating the retention time windows.

11.5.2. If there is a break in the analytical sequence of greater than 12 hours, a new analytical sequence must be started with a daily calibration.

11.6. Retention Time Windows

11.6.1. Retention time windows must be determined for all analytes. Make an injection of all analytes of interest each day over a three-day period. Calculate the standard deviation of the three retention times for each analyte (relative retention times may also be used). For multi-response analytes (e.g., Aroclors) use the retention time of major peaks. Plus or minus three times the standard deviation of the retention times of each analyte defines the retention time window.

11.6.2. The center of the retention time window is the retention time from the last of the three standards. The centers of the windows are updated with the mid- point of the initial calibration and each 12-hour calibration. The widths of the windows will remain the same until new windows are generated following the installation of a new column.

11.6.3. If the retention time window as calculated above is less than +/- 0.05 minutes, use +/- 0.05 minutes as the retention time window. This allows for slight variations in retention times caused by sample matrix.

11.6.4. The laboratory must calculate new retention time windows each time a new column is installed. The new windows must be generated within one week of the installation of the new column. Until these standards have been run on the new column, the retention time windows from the old column may be used, updated with the retention times from the new initial calibration.

11.6.5. Corrective Action for Retention Times

The retention times of all compounds in the 12 hour calibration or calibration verification standard must be within the retention time window. If this condition is not met, all samples analyzed after the last compliant standard must be reanalyzed unless the following conditions are met for any compound that elutes outside the retention time window:

The retention time of that compound in the standard must be within a retention time range equal to twice the original window.

No peak that would be reportable may be present on the sample chromatogram within an elution time range equal to three times the original retention time window.

11.7. Daily Retention Time Windows

The center of the retention time windows determined in Section 11.6 are adjusted to the retention time of each analyte as determined in the 12 hour calibration standards or continuing calibration verification standards. (See the method 8081A and 8082 appendices for exceptions for multi-response components.) The retention time windows must be updated at the beginning of each analytical sequence and with each 12-hour calibration or continuing calibration verification.

11.8. Percent Moisture

Analytical results may be reported as dry or wet weight, as required by the client. Percent moisture must be determined if results will be reported as dry weight. Refer to SOP CORP-OP-0001NC for determination of percent moisture.

11.9. Procedural Variations

Procedural variations are allowed only if deemed necessary in the professional judgment of the supervisor to accommodate variation in sample matrix, radioactivity, chemistry, sample size, or other parameters. Any variation in procedure shall be completely documented using a Nonconformance Memo and approved by a supervisor and QA/QC manager. If contractually required, the client shall be notified. The Nonconformance Memo shall be filed in the project file. The nonconformance is also addressed in the case narrative. Any unauthorized deviations from this procedure must also be documented as a nonconformance, with a cause and corrective action described.

12. DATA ANALYSIS AND CALCULATIONS

12.1. Qualitative Identification

12.1.1. Tentative identification occurs when a peak is found within the retention time window for an analyte, at a concentration above the reporting limit, or above the MDL if J flags are required. Normally confirmation is required on a second column, but if the detector is sufficiently specific or if the sample matrix is well enough defined, single column analysis may be adequate. In some cases GC/MS confirmation may be required. Client specific requirements may also define the need for second column confirmation and / or GC/MS confirmation. Refer to the appendices for test specific requirements for confirmation. Identification is confirmed if a peak is also present in the retention time window for that analyte on the confirmatory column, at a concentration greater than the reporting limit (MDL if J flag confirmation required).

12.1.2. Dual column quantitation

For confirmed results, two approaches are available to the analyst.
A) The primary column approach
Or
B) The better result approach
Both are acceptable to avoid the reporting of erroneous or unconfirmed data.

12.1.2.1. Primary column approach:

The result from the primary column is normally reported. The result from the secondary column is reported if any of the following three bulleted possibilities are true.

- There is obvious chromatographic interference on the primary column
- The result on the primary column is > 40% greater than the result on the secondary column
- Continuing or bracketing standard fails on the primary column but is acceptable on the secondary column. (If the primary column result is > 40% higher than the secondary and the primary column calibration fails, then the sample must be evaluated for reanalysis.)

12.1.2.2. Better result approach

The lower of the two results is normally reported. The lower result is considered better because the higher result is generally higher because of chromatographic interference. The higher result is reported if any of the following two bulleted possibilities are true.

- There is obvious chromatographic interference on the column with the lower result
- The continuing or bracketing calibration on the column with the lower result fails. (If the higher result is > 40% higher and the calibration on the column with the lower result fails, then the sample must be evaluated for reanalysis.)

12.1.3. If the Relative percent difference (RPD) between the response on the two columns is greater than 40%, or if the opinion of an experienced analyst is that the complexity of the matrix is resulting in false positives, the confirmation is suspect and the results are qualified. RPD is calculated using the following formula:

$$RPD = \frac{R_1 - R_2}{\frac{1}{2}(R_1 + R_2)}$$

Where R=Result

12.1.4. Multi-response Analytes

For multi-response analytes, the analyst should use the retention time window, but should rely primarily on pattern recognition. The pattern of peaks will normally serve as confirmation.

12.1.5. The experience of the analyst should weigh heavily in the interpretation of the chromatogram. For example, sample matrix or laboratory temperature fluctuation may result in variation of retention times.

12.2. Calibration Range

If concentrations of any analytes exceed the working range as defined by the calibration standards, then the sample must be diluted and reanalyzed. Dilutions should target the most concentrated analyte in the upper half (over 50% of the high level standard) of the calibration range. It may be necessary to dilute samples due to matrix.

12.3. Dilutions

Samples may be screened to determine the appropriate dilution for the initial run. If the initial diluted run has no hits or hits below 20% of the calibration range and the matrix allows for analysis at a lesser dilution, then the sample must be reanalyzed at a dilution targeted to bring the largest hit above 50% of the calibration range.

12.3.1. Guidance for Dilutions Due to Matrix

If the sample is initially run at a dilution and only minor matrix peaks are, then the sample should be reanalyzed at a more concentrated dilution. Analyst judgement is required to determine the most concentrated dilution that will not result in instrument contamination.

12.3.2. Reporting Dilutions

The most concentrated dilution with no target compounds above the calibration range will be reported. Other dilutions may be reported at client request, if the lower dilutions will not cause detector saturation, column overload, or carryover. Analyst judgement and client site history will factors in the reporting of dual dilutions.

12.4. Interferences

If peak detection is prevented by interferences, further cleanup should be attempted. If no further cleanup is reasonable, then elevation of reporting levels and/or lack of positive identification must be addressed in the case narrative.

12.5. Internal Standard Criteria for Continuing Calibration

If internal standard calibration is used, then the internal standard response in a continuing calibration standard must be within 50 to 150% of the response in the mid level of the initial calibration.

12.6. Calculations

Capabilities of individual data systems may require the use of different formulas than those presented here. When this is the case, the calculations used must be shown to be equivalent and must be documented in an appendix attached to this document.

12.6.1. External Standard Calculations

12.6.1.1. Aqueous samples

$$Concentration\ (mg\ /\ L) = \frac{(A_x \times V_t \times D_f)}{(CF \times V_i \times V_s)}$$

Where:

A_x = Response for the analyte in the sample
V_i = Volume of extract injected, µL
D_f = Dilution factor
V_t = Volume of total extract, µL
V_s = Volume of sample extracted or purged, mL
CF = Calibration factor, area or height/ng, Section 10.1

12.6.1.2. Non-aqueous Samples

$$Concentration\ (mg\ /\ kg) = \frac{(A_x \times V_t \times D_f)}{(CF \times V_i \times W \times D)}$$

Where:

W = Weight of sample extracted or purged, g

$$D = \frac{100 - \%Moisture}{100}$$ (D = 1 if wet weight is required)

12.6.2. Internal Standard Calculations

12.6.2.1. Aqueous Samples

$$Concentration\ (mg\ /\ L) = \frac{(A_x \times C_{is} \times D_f)}{(A_{is} \times RF \times V_s)}$$

Where:

C_{is} = Amount of internal standard added, ng
A_{is} = Response of the internal standard
RF = Response factor for analyte

12.6.2.2. Non-aqueous Samples

$$Concentration\ (mg\ /\ kg) = \frac{(A_x \times C_{is} \times D_f)}{(A_{is} \times RF \times W \times D)}$$

12.6.3. Surrogate Recovery

Concentrations of surrogate compounds are calculated using the same equations as for the target compounds. The response factor from the initial calibration is used. Surrogate recovery is calculated using the following equation:

$$\%\ \text{Recovery} = \frac{Concentration\ (or\ amount)\ found}{Concentration\ (or\ amount)\ spiked} \times 100$$

13. METHOD PERFORMANCE

13.1. Method Detection Limit

Each laboratory must generate a valid method detection limit for each analyte of interest. The MDL must be below the reporting limit for each analyte. The procedure for determination of the method detection limit is given in 40 CFR Part 136, Appendix B, and further defined in QA Policy #: QA-005.

13.2. Initial Demonstration

Each laboratory must make a one time initial demonstration of capability for each individual method. Demonstration of capability for both soils and water matrices is required. This requires analysis of QC check samples containing all of the standard analytes for the method. For some tests it may be necessary to use more than one QC check mix to cover all analytes of interest.

13.2.1. Four aliquots of the QC check sample are analyzed using the same procedures used to analyze samples, including sample preparation. The concentration of the QC check sample should be equivalent to a mid-level calibration.

13.2.2. Calculate the average recovery and standard deviation of the recovery for each analyte of interest. Compare these results with the acceptance criteria given in each appendix.

13.2.3. If any analyte does not meet the acceptance criteria, the test must be repeated. Only those analytes that did not meet criteria in the first test need to be evaluated. Repeated failure for any analyte indicates the need for the laboratory to evaluate the analytical procedure and take corrective action.

13.3. Training Qualification

The group/team leader has the responsibility to ensure that an analyst who has been properly trained in its use and has the required experience performs this procedure.

14. POLLUTION PREVENTION

This method does not contain any specific modifications that serve to minimize or prevent pollution.

15. WASTE MANAGEMENT

15.1. All waste will be disposed of in accordance with Federal, State and Local regulations. Where reasonably feasible, technological changes have been implemented to minimize the potential for pollution of the environment. Employees will abide by this method and the policies in section 13 of the Corporate Safety Manual for "Waste Management and Pollution Prevention."

15.2. Waste Streams Produced by the Method.

15.2.1. The following waste streams are produced when this method is carried out.

15.2.1.1. **Vials containing sample extracts:** These vials are placed in the vial waste located in the GC/MS laboratory.

15.2.1.2. **Tubes containing sample extracts for TPH, Pesticides, PCBs and Herbicides**: These capped tubes are placed in the PCB/flammable wste located the GC prep laboratory.

15.2.1.3. **Samples, standards, and all extraction materials contaminated with high levels (>50ppm) of PCB's must be segregated into their own waste stream.** PCB wastes are collected in one of three waste streams, solid PCB, liquid PCB and PCB vial waste. PCB containing samples are located through a LIMS query and disposed of as PCB containing.

15.2.1.4. **Extracted solid samples contaminated with methylene chloride/acetone or acetone/hexane.** These materials are disposed of in the solid waste and debris in a red container located in the extractions lab.

15.2.1.5. **Discarded samples**. These samples are collected in the solid debris drum.

16. REFERENCES

Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, SW846, 3rd Edition, Final Update III, December 1996, and Section 8000B

17. MISCELLANEOUS

17.1. Modifications from Reference Method

17.1.1. Chapter 1 of SW-846 states that the method blank should not contain any analyte of interest at or above the Method Detection Limit. This SOP states that the Method Blank must not contain any analyte of interest at or above the reporting limit. Common lab contaminants are allowed to be up to 5 times the reporting limit in the blank following consultation with the client.

17.2. Modifications from Previous Revision

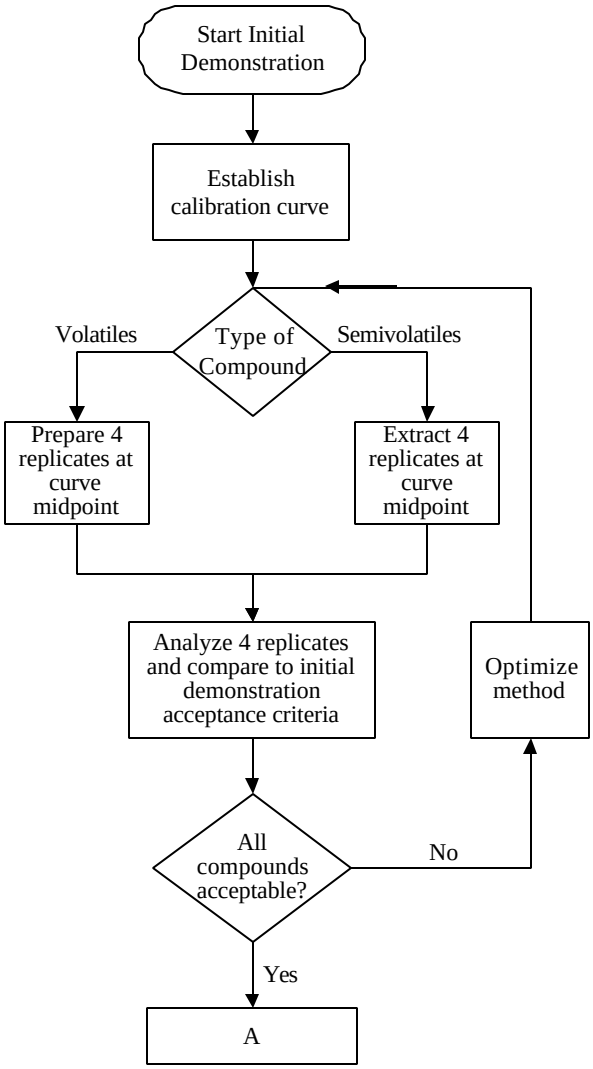
The calibration criteria in section 10.11 have been rewritten to improve consistency with SW-846 and to improve clarity.

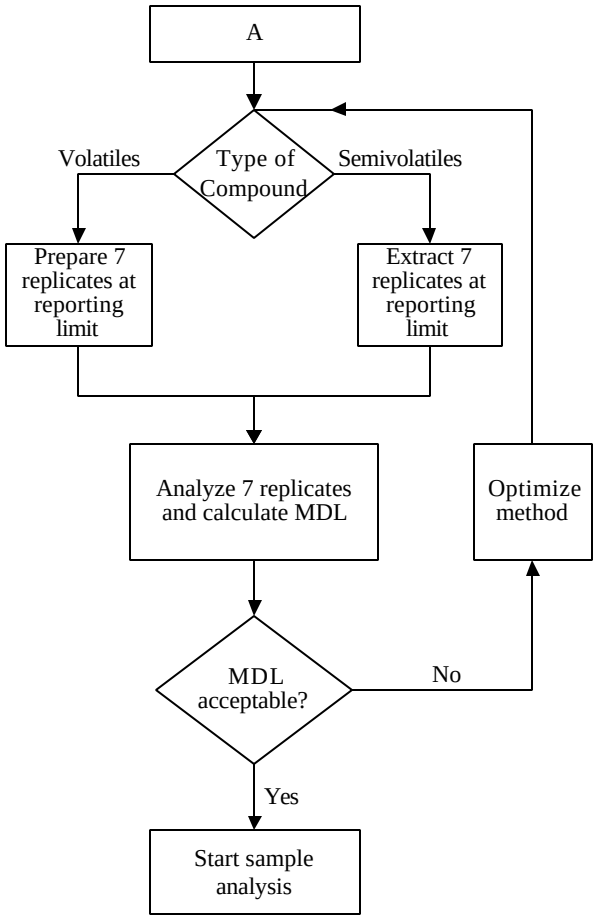
17.3. Facility Specific SOPs

Each facility shall attach a list of facility specific SOPs or approved attachments (if applicable) which are required to implement this SOP or which are used in conjunction with this SOP. If no facility specific SOPs or amendments are to be attached, a statement must be attached specifying that there are none.

17.4. Flow Diagrams

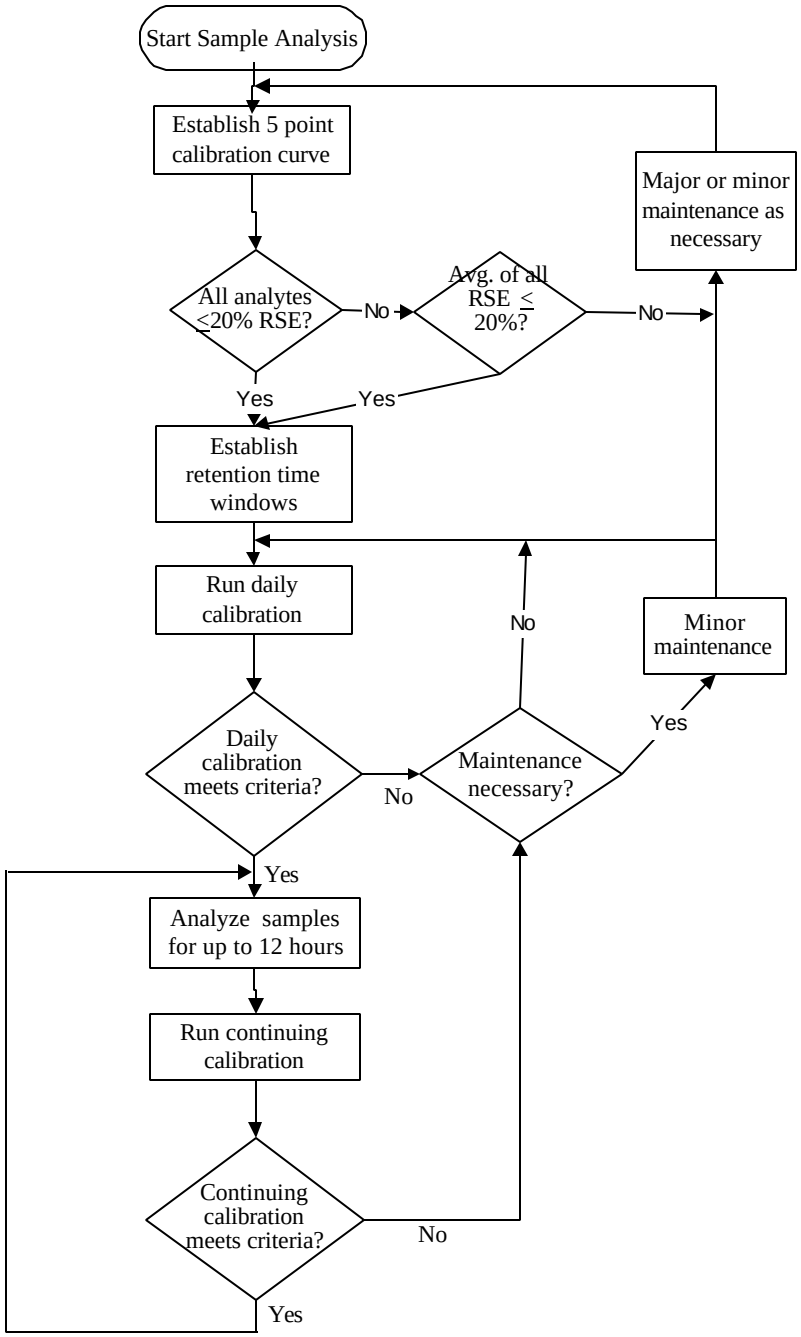
17.4.1. Initial demonstration and MDL[1]





[1] This flow diagram is for guidance and cannot cover all eventualities. Consult the SOP text and a supervisor if in doubt.

17.4.2. Sample Analysis [1]



[1] This flow diagram is for guidance and cannot cover all eventualities. Consult the SOP text and a supervisor if in doubt.

1. SCOPE AND APPLICATION

1.1. This method describes sample preparation and extraction for the analysis of volatile organics by a purge and trap procedure, following method 8021B. However, where required by a client QAPP this section may also be used to analyze aromatic volatiles by discontinued methods 8020A and 8010B. All requirements of the 8000B section of this SOP must be met except when superseded by this Appendix. Refer to Table A-1 for the individual analytes normally determined by these procedures.

1.2. Compounds within the scope of this method have boiling points below 200°C and are soluble or slightly soluble in water. Classes of compounds best suited to purge-and-trap analysis include low molecular weight halogenated hydrocarbons, aromatics, ketones, nitriles, acetates, acrylates, ethers, and sulfides.

1.3. Water samples and soils samples with low levels of contamination may be analyzed directly by purge-and-trap extraction and gas chromatography. Higher concentrations of these analytes in soil may be determined by the medium level methanol extraction procedure.

1.4. This method also describes the preparation of water-miscible liquids, non-water-miscible liquids, solids, wastes, and soils/sediments for analysis by the purge-and-trap procedure.

1.5. The associated LIMS method code is QR.

2. SUMMARY OF METHOD

2.1. An inert gas is bubbled through the sample at ambient temperature or at 40°C (40°C required for low-level soils), and the volatile components are transferred from the aqueous phase to the vapor phase. The vapor is swept through a sorbent column where the volatile components are adsorbed. After purging is completed, the sorbent column is heated and back-flushed with inert gas to desorb the components onto a gas chromatographic column. Analytes are detected using a photoionization Detector, an electrolytic conductivity detector or a combination of both.

2.2. For soil samples, a portion of the sample is dispersed in methanol to dissolve the volatile organic constituents. A portion of the methanolic solution is combined with water. It is then analyzed by purge-and-trap GC following the normal water method. If very low detection limits are needed for soil samples then direct purge using sodium bisulfate preservation may be necessary.

3. DEFINITIONS

Refer to the STL North Canton Laboratory Quality Manual (LQM), current version, for definitions of terms used in this SOP.

4. INTERFERENCES

4.1. Refer to section 4 of the method 8000B part of this SOP for general information on chromatographic interferences.

4.2. Impurities in the purge gas, and from organic compounds out-gassing from the plumbing ahead of the trap, account for the majority of contamination problems. The analytical system must be demonstrated to be free from contamination under the conditions of the analysis by running laboratory reagent blanks. The use of non-TFE plastic tubing, non-TFE thread sealants, or flow controllers with rubber components in the purging device should be avoided.

4.3. Samples can be contaminated by diffusion of volatile organics (particularly methylene chloride and fluorocarbons) through the septum seal of the sample vial during shipment and storage. A trip blank

prepared from organic-free reagent water and carried through sampling and handling protocols serves as a check on such contamination.

4.4. Contamination by carryover can occur whenever high-concentration and low-concentration samples are analyzed sequentially. Whenever an unusually concentrated sample is analyzed, it should be followed by an analysis of organic-free reagent water to check for cross-contamination. The trap and other parts of the system are subject to contamination. Therefore, frequent bake-out and purging of the system may be required.

4.5. When utilizing an autosampler system, which has multiple ports for sample analysis, it is likely that only a single stage or port may be contaminated by a highly concentrated sample. If a port is suspect, a water blank should be analyzed to verify lack of contamination. If the water blank and subsequent blanks on that port show contamination consistent with the concentrated sample, further maintenance is required. This may include replacing or cleaning the multi-port valve, transfer lines, etc.

4.6. A holding blank is kept in the sample refrigerator. This is analyzed and replaced every 14 days. If the holding blank does not meet the method blank criteria, the source of contamination must be found and corrected. Evaluation of all samples analyzed in the 14-day period prior to the analysis of the contaminated holding blank is required.

4.7. Acidification of samples may result in hydrolysis of 2-chloroethyl-vinyl ether.

5. SAFETY

5.1. Refer to section 5 of the Method 8000B section of this SOP for general safety requirements.

5.2. Often, purge vessels on purge-and-trap instrumentation are pressurized by the time analysis is completed. Therefore, vent the pressure prior to removal of these vessels to prevent the contents from spraying out.

5.3. The toxicity or carcinogenicity of each chemical used in this procedure has not been fully defined. Additional health and safety information can be obtained from the MSDS files maintained in the laboratory. The following specific hazards are known:

Methanol -- Flammable and toxic

5.4. The following method analytes have been tentatively classified as known or suspected human or mammalian carcinogens: Benzene, Carbon Tetrachloride, 1,4-Dichlorobenzene, 1,2-Dichloroethane, Hexachlorobutadiene, 1,1,2,2-Tetrachloroethane, 1,1,2-Trichloroethane, Chloroform, 1,2-Dibromoethane, Tetrachloroethene, Trichloroethene, Vinyl Chloride. Pure standard materials and stock standard solutions of these compounds should be handled in a hood.

5.5. Methanol shall not be used in a CaptAir hood.

5.6. GC VOA instruments use an ultraviolet (UV) light source, which must be shielded from view. There should also be a warning label/sticker on each instrument that identifies it as a UV light source.

5.7. Sodium bisulfate creates Sulfuric Acid when mixed with water.

6. EQUIPMENT AND SUPPLIES

6.1. Microsyringes -- 10µL, 25µL, 100µL, 250µL, 500µL, and 1000µL. These should be equipped with a 20 gauge (0.006" ID) needle. These will be used to measure and dispense methanolic solutions and aqueous samples.

6.2. Gas tight syringes -- 5 mL and 25 mL. Used for measuring sample volumes.

6.3. Purge and Trap Apparatus -- A device capable of extracting volatile compounds, trapping on a sorbent trap, and introducing onto a gas chromatograph.

6.4. Purge and Trap Autosampler -- In order to maintain high sample throughput, an autosampler is highly recommended.

6.5. Trap -- The trap used is dependent on the class of compound to be analyzed. Refer to Table A-2 for suggested traps for specific tests.

6.6. Purge Vessels -- These are dependent on the purge and trap unit/autosampler used. Both disposable culture tubes (needle sparge units) and specially designed vessels with fritted bottoms may be used. Follow the manufacturer's suggestions for configuration.

6.7. Columns - Refer to Table A-2 for details of columns.

6.8. Volumetric flasks, Class A: 5 mL to 250 mL

6.9. pH paper

6.10. Balance capable of weighing to 0.01g for samples.

7. REAGENTS AND SUPPLIES

7.1. Refer to the method 8000B section of this SOP for general requirements for reagents and supplies.

7.2. Organic Free Water

Organic free water is defined as water in which an interferent is not observed at the reporting limit of the compounds of interest. Suggested methods for generating organic free water include:

- Filtration through a carbon bed.
- Continuously sparging water with helium or nitrogen.
- Use of commercial water purification systems.

Other methods may be used, so long as the requirement that the water show no interference is met. The procedure used should be documented in a lab specific attachment.

7.3. Sodium Bisulfate

7.4. Methanol -- Purge and Trap Grade

7.5. Standards

Refer to tables A-5 and A-6 for details of surrogate, matrix spiking and internal standards. Calibration standard levels are not specified, since they may depend on the sensitivity and linear range of specific detectors. However, the low level standard must be equivalent to the reporting limits specified in Table A-1.

7.5.1. Volatile standards are prepared by injecting a measured volume of the stock standard into a syringe containing the appropriate volume of organic free water. The calibration standard is then loaded into the purge device.

8. SAMPLE COLLECTION, PRESERVATION, AND STORAGE

8.1. Holding times for all volatile analysis are 14 days from sample collection.

8.2. Water samples are normally preserved at pH < 2 with 1:1 hydrochloric acid. If residual chlorine is present, 2 drops of 10% sodium thiosulfate are added.

8.3. Solid samples are field preserved with sodium bisulfate solution for low level analysis, or with methanol for medium level analysis. Soil samples can also be taken using the EnCore™ sampler and preserved in the lab within 48 hours of sampling. At specific client request, unpreserved soil samples may be accepted.

8.4. There are several methods of sampling soil. The recommended method, which provides the minimum of field difficulties, is to take an EnCore sample. (The 5 g or 25 g sampler can be used, depending on client preference). Following shipment back to the lab the soil is preserved in methanol. This is the medium level procedure. If very low detection limits are needed (< 50 µg/kg for most analytes) then it will be necessary to use two additional 5 g EnCore samplers or to use field preservation.

8.5. Sample collection for medium level analysis using EnCore samplers.

8.5.1. Ship one 5 g (or 25 g) EnCore sampler per field sample position.

8.5.2. An additional bottle must be shipped for percent moisture determination.

8.5.3. When the samples are returned to the lab, extrude the (nominal) 5g (or 25 g) sample into a tared VOA vial containing 5 mL methanol (25 mL methanol for the 25 g sampler). Obtain the weight of the soil added to the vial and note on the label.

8.5.4. Add the correct amount of surrogate spiking mixture. (Add 100 µL of 250 µg/mL solution for a nominal 25 g sample, 20µL for a nominal 5 g sample.)

8.5.5. Add the correct amount of matrix spiking solution to the matrix spike and matrix spike duplicate samples. (Add 100 µL of 250 µg/mL solution for a nominal 25 g sample, 20µL for a nominal 5 g sample.) The addition of spike introduces a slight error, (0.4%) which can be neglected, into the calculations.

8.5.6. Prepare an LCS for each batch by adding the correct amount of matrix spiking solution to clean methanol. (100 µL of spike to 25 mL methanol or 20 µL spike to 5 mL methanol).

8.5.7. Shake the samples for two minutes to distribute the methanol throughout the soil.

8.5.8. Allow to settle, then remove a portion of methanol and store in a clean Teflon capped vial at 4+2°C until analysis.

8.6. Sample collection for medium level analysis using field methanol preservation

8.6.1. Prepare a VOA vial by adding 5 mL purge and trap grade methanol. (If a 25 g sample is to be used, add 25 mL methanol to the VOA vial).

8.6.2. Seal the bottle and attach a label.

8.6.3. Weigh the bottle to the nearest 0.01g and note the weight on the label.

8.6.4. Ship with appropriate sampling instructions.

8.6.5. Each sample will require an additional bottle with no preservative for percent moisture determination.

8.6.6. At client request, the methanol addition and weighing may also be performed in the field.

8.6.7. When the samples are returned to the lab, obtain the weight of the soil added to the vial and note on the label.

8.6.8. Add the correct amount of surrogate spiking mixture. (Add 100 µL of 250 µg/mL solution for a nominal 25 g sample, 20µL for a nominal 5 g sample.)

8.6.9. Add the correct amount of matrix spiking solution to the matrix spike and matrix spike duplicate samples. (Add 100 µL of 250 µg/mL solution for a nominal 25 g sample, 20µL for a nominal 5 g sample.) The addition of spike introduces a slight error, (0.4%) which can be neglected, into the calculations.

8.6.10. Prepare an LCS for each batch by adding the correct amount of matrix spiking solution to clean methanol. (100 µL of spike to 25 mL methanol or 20 µL spike to 5 mL methanol).

8.6.11. Shake the samples for two minutes to distribute the methanol throughout the soil.

8.6.12. Allow to settle, then remove a portion of methanol and store in a clean Teflon capped vial at 4+2°C until analysis.

8.7. Low level procedure

8.7.1. If low detection limits are required (typically < 50 µg/kg) sodium bisulfate preservation must be used. However, it is also necessary to take a sample for the medium level (methanol preserved) procedure, in case the concentration of analytes in the soil is above the calibration range of the low-level procedure.

8.7.2. A purge and trap autosampler capable of sampling from a sealed vial is required for analysis of samples collected using this method. (Varian Archon or O.I. 4552).

8.7.3. The soil sample is taken using a 5g EnCore sampling device and returned to the lab. It is recommended that two EnCore samplers be used for each field sample position, to allow for any reruns than may be necessary. A separate sample for % moisture determination is also necessary.

8.7.4. Prepare VOA vials by adding a magnetic stir bar, approximately 1 g of sodium bisulfate and 5 mL of reagent water.

8.7.5. Seal the vial and attach a label. The label must not cover the neck of the vial or the autosampler will malfunction.

8.7.6. Weigh the vial to the nearest 0.01g and note the weight on the label.

8.7.7. Extrude the soil sample from the EnCore sampler into the prepared VOA vial. Reweigh the vial to obtain the weight of soil and note on the label.

8.7.8. **Note:** Soils containing carbonates may effervesce when added to the sodium bisulfate solution. If this is the case at a specific site, add 5 mL of water instead, and freeze at $\geq$ -10°C until analysis.

8.7.9. Alternatively the sodium bisulfate preservation may be performed in the field. Ship at least two vials per sample. The field samplers must determine the weight of soil sampled. Each sample will

require an additional bottle with no preservative for percent moisture determination, and an additional bottle preserved with methanol for the medium level procedure.

8.8. Aqueous samples are stored in glass containers with Teflon lined septa at 4°C +/- 2°C, with minimum headspace.

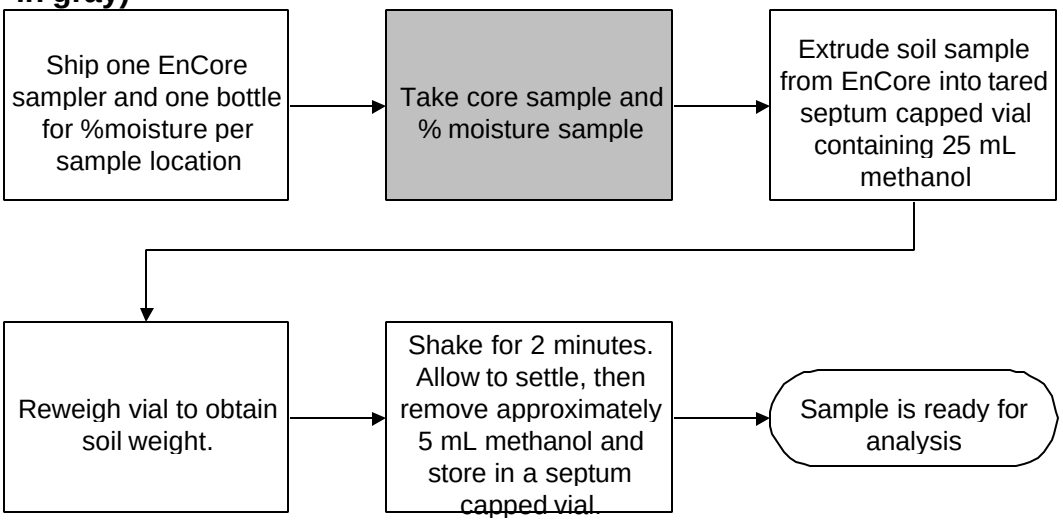
8.9. Medium level solid extracts are aliquoted into 2 - 5 mL glass vials with Teflon lined caps and stored at 4°C +/- 2°C. The extracts are stored with minimum headspace.

8.10. The maximum holding time is 14 days from sampling until the sample is analyzed. (Samples that are found to be unpreserved still have a 14 day holding time. However they should be analyzed as soon as possible. The lack of preservation should be addressed in the case narrative). Maximum holding time for the EnCore sampler (before the sample is added to methanol or sodium bisulfate) is 48 hours.

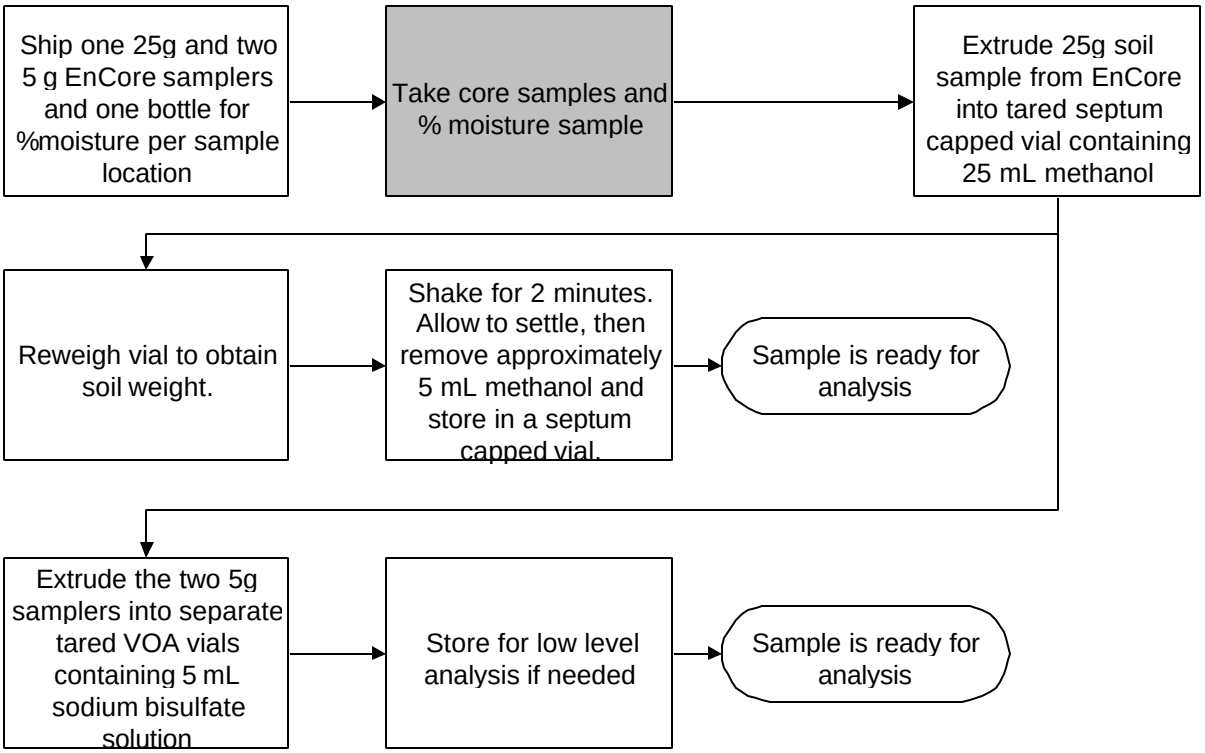
8.11. A holding blank is stored with the samples. This is analyzed and replaced if any of the trip blanks show any contamination. Otherwise it is replaced every 14 days.

Note: Freezing is not allowed for Ohio VAP solids.

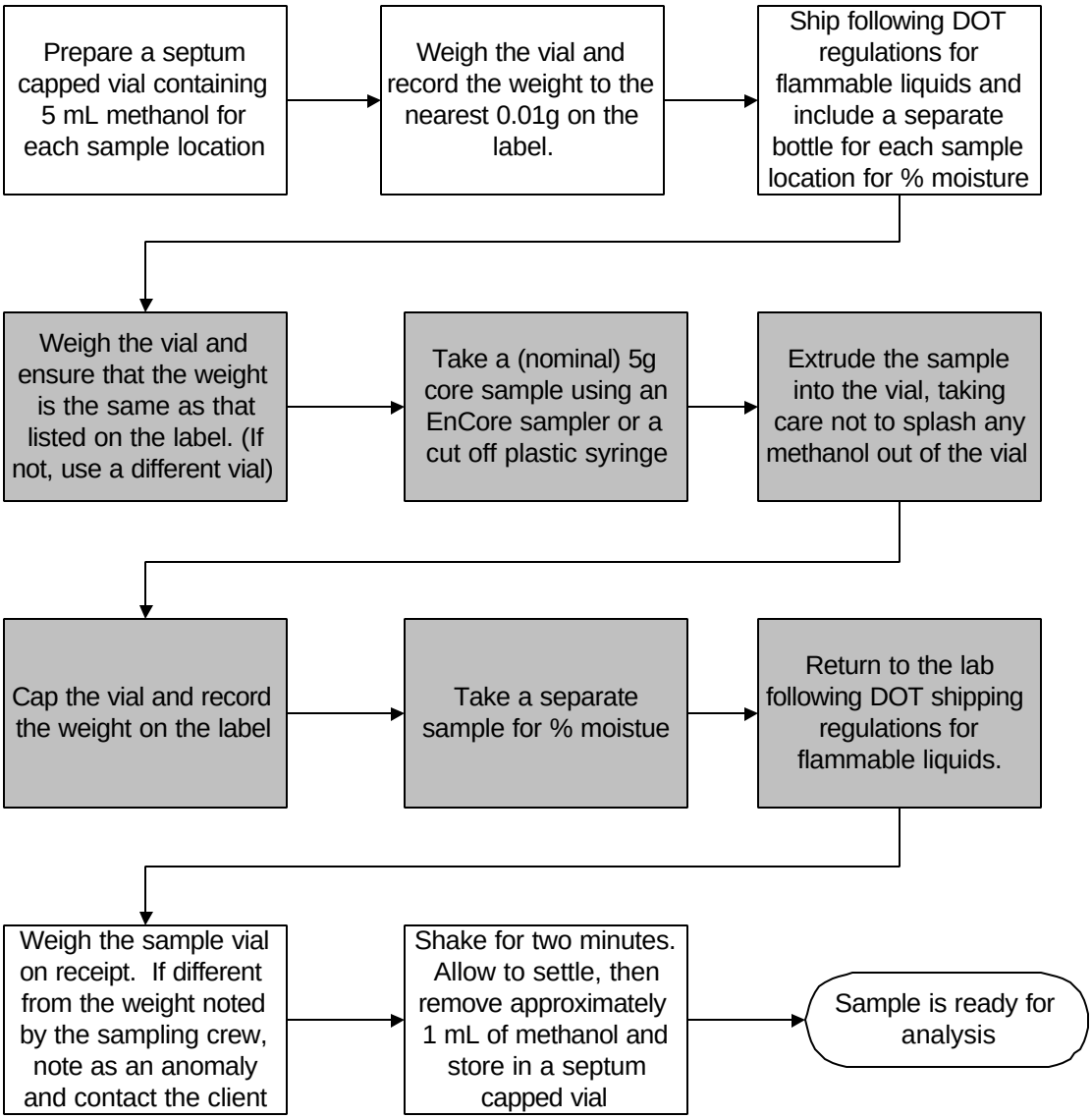
EnCore procedure when low level is not required (field steps in gray)



EnCore procedure when low level is required



Field methanol extraction procedure (field steps in gray)



9. QUALITY CONTROL

9.1. Refer to the method 8000B section of this SOP, section 9, for general quality control procedures, including batch definition, requirements for method blanks, LCS, matrix spikes, surrogates, and control limits.

10. CALIBRATION AND STANDARDIZATION

10.1. Refer to the method 8000B section of this SOP, section 10, for general calibration procedures.

10.2. Gas Chromatograph Operating Conditions

Various column configurations are possible. If dual column confirmation is necessary, the sample may be split using a Y splitter at the injector end to direct the sample to two columns and two detectors. For simultaneous determination of aromatic and halogenated volatiles, a single column is used and the PID and ELCD detectors are connected in series.

10.2.1. Refer to Table A-2, A-3 and A-4 for GC operating conditions.

10.3. Initial Calibration

10.3.1. Refer to Section 10 of the 8000B section of this SOP for details of initial calibration criteria.

10.3.2. Low level soil samples must be purged at 40°C; therefore the calibration curve must also be purged at 40°C. In addition, the low level soil calibration solutions should contain approximately the same amount of sodium bisulfate as the samples.

10.3.3. The low level calibration must be at the reporting limit or below. The remaining standards encompass the working range of the detector.

10.3.4. Calibrate the instrument using the same volume that will be used during sample analysis.

10.4. Calibration Verification

10.4.1. A mid level calibration standard is used for the calibration verification. The gases have 20 % D criteria rather than the 15% used for other analytes.

10.4.2. A calibration verification run is performed after every 10 samples for this method.

10.4.3. Bracketing of samples with calibration verification runs is only necessary for external standard analysis.

11. PROCEDURE

11.1. Refer to the method 8000B section of this SOP for general procedural requirements.

11.2. Analytical Sequence

The analytical sequence starts with an initial calibration of at least five points, or a 12 hour calibration that meets % difference criteria from an existing initial calibration.

11.3. Confirmation

The PID and ELCD detectors are sufficiently selective that second column confirmation is not always necessary. Requirements for second column confirmation should be decided in consultation with the

client. If the PID and ELCD are used in series confirmatory information for many analytes can be gained by comparing the relative response from the two detectors.

11.4. Aqueous Sample Analysis (Purge and Trap units using sparge vessels)

11.4.1. Depending on the sensitivity of the instrument and capabilities of the purge and trap device, 5, 10, 20, or 25 mL sample volumes may be analyzed. A 5 mL sample volume is recommended.

11.4.2. Rinse a 5 mL (or 25 mL for larger sample volumes) gas-tight syringe with organic free water. Fill the syringe with the sample to be analyzed, and compress to volume.

11.4.3. Check and document the pH of the sample remaining in the VOA vial after loading the syringe.

11.4.4. This procedure invalidates the contents of the VOA vial for further analysis, unless an aliquot is transferred to a smaller VOA vial with no headspace (e.g., 20 mL) at the same time the analysis aliquot is removed.

11.4.5. Spike with the appropriate volume of surrogate/internal standard solution and spike solution (if required) through the barrel of the syringe. The method blank is spiked with surrogates only, the LCS and matrix spikes with the surrogate and matrix spiking solutions. Refer to Tables A-5 and A-6 for volumes and concentrations of spiking solutions.

11.4.6. Load onto the purge and trap device and start the run.

11.4.7. If the initial analysis of a sample or a dilution of the sample has a concentration of analytes that exceeds the initial calibration range, the sample must be reanalyzed at a higher dilution. When a sample has a high response for a compound, an organic free water blank should follow analysis. It is recognized that during automated unattended analysis, this may not occur. If any potential carryover hits are present in samples following highly contaminated samples, the sample must be reanalyzed to determine if any of these hits are a result of carryover or are actually present in the sample.

11.4.8. Dilutions may be made in gas tight syringes unless the volume of sample used is less than 5 µL, in which case dilution in volumetric flasks will be necessary.

11.4.8.1. Spike with the same volume of surrogate/internal standard solution as used for undiluted samples prior to loading onto the purge and trap device.

11.4.8.2. For Matrix spike / matrix spike duplicates where the sample requires dilution, the sample is spiked <u>after</u> the dilution is performed.

11.5. Aqueous and Soil Sample Analysis (Purge and Trap units that sample directly from the VOA vial)

11.5.1. Units, which sample from the VOA vial, should be equipped with a module, which automatically adds surrogate and internal standard solution to the sample prior to purging the sample.

11.5.2. If the autosampler uses automatic IS/SS injection, no further preparation of the VOA vial is needed. Otherwise the internal and surrogate standards must be added to the vial. *Note:* Aqueous samples with high amounts of sediment present in the vial may not be suitable for analysis on this instrumentation, or they may need to analyzed as soils.

11.5.3. Sample remaining in the vial after sampling with one of these mechanisms is no longer valid for further analysis. A fresh VOA vial must be used for further sample analysis.

11.5.4. Check the pH of the sample remaining in the VOA vial after analysis is completed.

11.6. Low-Level Solids Analysis using discrete autosamplers

Note: This technique may seriously underestimate analyte concentration and must not be used except at specific client request for the purpose of comparability with previous data. It is no longer part of SW-846.

This method is based on purging a heated sediment/soil sample mixed with reagent water containing the surrogate and, if applicable, internal and matrix spiking standards. Analyze all reagent blanks and standards under the same conditions as the samples (e.g., heated). The calibration curve is also heated during analysis. Purge temperature is 40°C.

11.6.1. Do not discard any supernatant liquids. Mix the contents of the container with a narrow metal spatula.

11.6.2. Weigh out 5 g (or other appropriate aliquot) of sample into a disposable culture tube or other purge vessel. Record the weight to the nearest 0.1 g. If method sensitivity is demonstrated, a smaller aliquot may be used. Do not use aliquots less than 1.0 g. If the sample is contaminated with analytes such that a purge amount less than 1.0 g is appropriate, use the medium level method described in section 11.7.

11.6.3. Connect the purge vessel to the purge and trap device.

11.6.4. Rinse a 5 mL gas-tight syringe with organic free water, and fill. Compress to 5 mL. Add surrogate/internal standard (and matrix spike solutions if required.) (See Tables A-5, A-6, A-7 and A-8.) Add directly to the sample from 11.6.2.

11.6.5. The above steps should be performed rapidly and without interruption to avoid loss of volatile organics.

11.6.6. Add the heater jacket or other heating device and start the purge and trap unit.

11.6.7. Soil samples that have low IS recovery when analyzed (<50%) should be reanalyzed once to confirm matrix effect. If external standard calibration is used, samples with surrogate recovery below the control limit should be reanalyzed once to confirm matrix effect.

11.7. Methanol Extract Soils

11.7.1. Rinse a gas-tight syringe with organic free water. Fill the syringe with the same volume of organic free water as used in the calibrations. Add no more than 2% (v/v) (100 µL for a 5 mL purge) methanolic extract (from Section 8.5 or 8.6) to the syringe. Add internal standard (if used). Load the sample onto the purge and trap device and analyze as for aqueous samples. If less than 5µL of methanolic extract is to be added to the water, dilute the methanolic extract such that a volume greater than 5µL will be added to the water in the syringe.

12. DATA ANALYSIS AND CALCULATIONS

Refer to section 12 of the 8000B section of this SOP.

13. METHOD PERFORMANCE

13.1. Performance limits for the four replicate initial demonstration of capability required under Section 13.1 of the 8000B section of this SOP.

14. POLLUTION PREVENTION

This method does not contain any specific modifications that serve to minimize or prevent pollution.

15. WASTE MANAGEMENT

15.1. All waste will be disposed of in accordance with Federal, State and Local regulations. Where reasonably feasible, technological changes have been implemented to minimize the potential for pollution of the environment. Employees will abide by this method and the policies in section 13 of the Corporate Safety Manual for "Waste Management and Pollution Prevention."

15.2. Waste streams produced by the method.

15.2.1. The following waste streams are produced when this method is carried out.

15.2.1.1. **Acidic material from the auto-sampler.** Waste stream must be collected and neutralized before discharge to a sewer system if the pH is less than 4.

15.2.1.2. **Methanol waste from rinses and standards**. Methanol waste is discarded as a flammable liquid .

15.2.1.3. **All samples including purged and extracted soils and waters:** Samples are collected in boxes and removed from the lab to storage. The waste coordinator handles crushing the vials and proper disposal.

16. REFERENCES

16.1. Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, SW846, 3rd Edition, Final Update III, December 1996, Sections 5000, 5030B, 5035 and 8021B

17. MISCELLANEOUS

17.1. Modifications from Reference Method

17.2. Modifications from previous revision

17.2.1. No revisions were made to this appendix.

17.3. Facility Specific SOPs

Each facility shall attach a list of facility specific SOPs or approved attachments (if applicable) which are required to implement this SOP or which are used in conjunction with this SOP. If no facility specific SOPs or amendments are to be attached, a statement must be attached specifying that there are none.

17.4. Tables

Table A-1					
Standard Analyte List					
Test	Compound	CAS number	Reporting Limit, µg/L or µg/kg		
			Aqueous	Low Soil	Medium Soil
Halogenated volatiles by 8021B	Bromodichloromethane	75-27-4	1.0	1.0	50
	Bromoform	75-25-2	1.0	1.0	50
	Bromomethane	74-83-9	1.0	1.0	50
	Carbon Tetrachloride	56-23-5	1.0	1.0	50
	Chlorobenzene	108-90-7	1.0	1.0	50
	Chloroethane	70-00-3	1.0	1.0	50
	2-Chloroethyl vinyl ether	110-75-8	5.0	5.0	250
	Chloroform	67-66-3	1.0	1.0	50
	Chloromethane	74-87-3	1.0	1.0	50
	Dibromochloromethane	124-48-1	1.0	1.0	50
	1,2-Dichlorobenzene	95-50-1	1.0	1.0	50
	1,3-Dichlorobenzene	541-73-1	1.0	1.0	50
	1,4-Dichlorobenzene	106-46-7	1.0	1.0	50
	Dichlorodifluoromethane	75-71-8	1.0	1.0	50
	1,1-Dichloroethane	75-34-3	1.0	1.0	50
	1,2-Dichloroethane	107-06-2	1.0	1.0	50
	1,1-Dichloroethene	75-45-4	1.0	1.0	50
	cis-1,2 Dichloroethene	156-59-4	1.0	1.0	50
	trans-1,2-Dichloroethene	156-60-5	1.0	1.0	50
	Dichloromethane(DCM)	75-09-2	5.0	5.0	250
	1,2-Dichloropropane	78-87-5	1.0	1.0	50
	cis-1,3-Dichloropropene	10061-01-5	1.0	1.0	50
	trans-1,3-Dichloropropene	10061-02-6	1.0	1.0	50
	1,1,2,2-Tetrachloroethane	79-34-5	1.0	1.0	50
	Tetrachloroethene	127-18-4	1.0	1.0	50
	1,1,1-Trichloroethane	71-55-6	1.0	1.0	50
	1,1,2-Trichloroethane	79-00-5	1.0	1.0	50
	Trichloroethene	79-01-6	1.0	1.0	50
	Trichlorofluoromethane	75-69-4	1.0	1.0	50
	Vinyl Chloride	75-01-4	1.0	1.0	50
Additional halogenated volatiles	Benzyl Chloride	100-44-7	5.0	5.0	250
	Bromobenzene	108-86-1	1.0	1.0	50
	Dibromomethane	74-95-3	1.0	1.0	50
	1,1,1,2-Tetrachloroethane	630-20-6	1.0	1.0	50
	Freon 113	76-13-1	1.0	1.0	50
	1,2,3-Trichloropropane	96-18-4	1.0	1.0	50
BTEX by 8021B	Benzene	71-43-2	1.0	1.0	50
	Ethyl Benzene	100-41-4	1.0	1.0	50
	Toluene	108-88-3	1.0	1.0	50
	Xylenes (total)	1330-20-7	1.0	1.0	50
Aromatic	Benzene	71-43-2	1.0	1.0	50

Table A-1

Standard Analyte List

Test	Compound	CAS number	Reporting Limit, µg/L or µg/kg		
			Aqueous	Low Soil	Medium Soil
volatiles by 8021B					
	Chlorobenzene	108-90-7	1.0	1.0	50
	1,2-Dichlorobenzene	75-34-3	1.0	1.0	50
	1,3-Dichlorobenzene	107-06-2	1.0	1.0	50
	1,4-Dichlorobenzene	75-45-4	1.0	1.0	50
	Ethyl Benzene	100-41-4	1.0	1.0	50
	Toluene	108-88-3	1.0	1.0	50
	Xylenes (total)	1330-20-7	1.0	1.0	50
Additional aromatic and unsaturated volatiles	1,2,4 Trimethylbenzene	95-63-6	1.0	1.0	50
	1,3,5 Trimethylbenzene	108-67-8	1.0	1.0	50
	Acetone	67-64-1	10	10	500
	MEK (2-butanone)	78-93-3	5.0	5.0	250
	MIBK (4-methyl-2-pentanone)	108-10-1	5.0	5.0	250
	Naphthalene	91-20-3	2.0	2.0	250
	Styrene	100-42-5	1.0	1.0	50
	Methyl tert-butyl ether (MTBE)	1634-04-4	1.0	1.0	50
Combined halogenated and aromatic volatiles by 8021B	Benzene	71-43-2	1.0	1.0	50
	Bromobenzene	108-86-1	1.0	1.0	50
	Bromochloromethane	74-97-5	1.0	1.0	50
	Bromodichloromethane	75-27-4	1.0	1.0	50
	Bromoform	75-25-2	1.0	1.0	50
	Bromomethane	74-83-9	1.0	1.0	50
	n-butylbenzene	104-51-8	1.0	1.0	50
	sec-Butylbenzene	135-98-8	1.0	1.0	50
	tert-Butylbenzene	98-06-6	1.0	1.0	50
	Carbon Tetrachloride	56-23-5	1.0	1.0	50
	Chlorobenzene	108-90-7	1.0	1.0	50
	Chlorodibromomethane	124-48-1	1.0	1.0	50
	Chloroethane	75-00-3	1.0	1.0	50
	Chloroform	67-66-3	1.0	1.0	50
	Chloromethane	74-87-3	1.0	1.0	50
	2-Chlorotoluene	95-49-8	1.0	1.0	50
	4-Chlorotoluene	106-43-4	1.0	1.0	50
	1,2-Dibromo-3-Chloropropane(DBCP)	96-12-8	1.0	1.0	50
	1,2-Dibromoethane(EDB)	106-93-4	1.0	1.0	50
	Dibromomethane	74-95-3	1.0	1.0	50
	1,2-Dichlorobenzene	95-50-1	1.0	1.0	50
	1,3-Dichlorobenzene	541-73-1	1.0	1.0	50
	1,4-Dichlorobenzene	106-46-7	1.0	1.0	50
	Dichlorodifluoromethane	75-71-8	1.0	1.0	50
	1,1-Dichloroethane	75-34-3	1.0	1.0	50
	1,2-Dichloroethane	107-06-2	1.0	1.0	50
	1,1-Dichloroethene	75-35-4	1.0	1.0	50

Table A-1

Standard Analyte List

Test	Compound	CAS number	Reporting Limit, µg/L or µg/kg		
			Aqueous	Low Soil	Medium Soil
	cis-1,2-Dichloroethene	156-59-4	1.0	1.0	50
	trans-1,2-Dichloroethene	156-60-5	1.0	1.0	50
	1,2-Dichloropropane	78-87-5	1.0	1.0	50
	1,3-Dichloropropane	142-28-9	1.0	1.0	50
	2,2-Dichloropropane	590-20-7	1.0	1.0	50
	1,1-Dichloropropene	563-58-6	1.0	1.0	50
	cis-1,3-Dichloropropene	10061-01-5	1.0	1.0	50
	trans-1,3-Dichloropropene	10061-02-6	1.0	1.0	50
	Ethylbenzene	100-41-4	1.0	1.0	50
	Hexachlorobutadiene	87-68-3	1.0	1.0	50
	Isopropylbenzene	98-82-8	1.0	1.0	50
	p-Isopropyltoluene	99-87-6	1.0	1.0	50
	Methylene Chloride	75-09-2	5.0	5.0	250
	Naphthalene	91-20-3	2.0	2.0	250
	n-Propylbenzene	10306501	1.0	1.0	50
	Styrene	100-42-5	1.0	1.0	50
	1,1,1,2-Tetrachloroethane	630-20-6	1.0	1.0	50
	1,1,2,2-Tetrachloroethane	79-34-5	1.0	1.0	50
	Tetrachloroethene	127-18-4	1.0	1.0	50
	Toluene	108-88-3	1.0	1.0	50
	1,2,3-Trichlorobenzene	87-61-6	1.0	1.0	50
	1,2,4-Trichlorobenzene	120-82-1	1.0	1.0	50
	1,1,1-Trichloroethane	71-55-6	1.0	1.0	50
	1,1,2-Trichloroethane	79-00-5	1.0	1.0	50
	Trichloroethene	79-01-6	1.0	1.0	50
	Trichlorofluoromethane	75-69-4	1.0	1.0	50
	1,2,3-Trichloropropane	96-18-4	1.0	1.0	50
	1,2,4-Trimethylbenzene	95-63-6	1.0	1.0	50
	1,3,5-Trimethylbenzene	108-67-8	1.0	1.0	50
	Vinyl Chloride	75-01-4	1.0	1.0	50
	Xylenes (total)	1330-20-7	1.0	1.0	50

Table A-2
Recommended Conditions for Aromatic Volatiles

Parameter	**Recommended Conditions**
Temperature program	50°C, 1min, 10°C/min to 200°C,1min
Column 1	Rtx-502.2 or DB-502.2 60m x 0.53mm 3.0um
Column 2	Rtx-1 or DB-1 60m x 0.53mm 3.0 um
Carrier gas	Helium or hydrogen
Purge Flow / time	40 mL/min, 11 minutes
Desorb Temp / time	180°C, 2 minutes (220°C for Vocarb 3000)
Bake Time / temp	200°C, 12 minutes (230°C for Vocarb 3000)
Transfer line / valve temp	115°C

Table A-3
Recommended Conditions for Method Halogenated Volatiles

Parameter	Recommended Conditions
Temperature program	35°C, 12 min, then 4°C/min to 200°C, hold for 5 min
Column 1	DB-VRX or RTX-502.2 105m x 0.53 mm id df = 3.0um
Column 2	DB-1 or RTX-1 105m x 0.53 mm ID df = 3.0um
Column 3	Rtx - Volatiles 120m x 0.53mm ID df=2.0um
Carrier gas	Helium
Purge Flow / time	40 mL/min, 11 minutes
Desorb Temp / time	180°C, 2 minutes (220°C for Vocarb 3000)
Bake Time / temp	200°C, 12 minutes (230°C for Vocarb 3000)
Transfer line / valve temp	115°C

Table A-4
Recommended Conditions for Method Combined Aromatic and Halogenated Volatiles

Parameter	Recommended Conditions
Temperature program	35°C, 12 min, then 4°C/min to 200°C, hold for 5 min
Column 1	DB-VRX or RTX-502.2 105m x 0.53 mm id df = 3.0um
Column 2	DB-1 or RTX-1 105m x 0.53 mm ID df = 3.0um
Column 3	Rtx - Volatiles 120m x 0.53mm ID df=2.0um
Carrier gas	Helium
Purge Flow / time	40 mL/min, 11 minutes
Desorb Temp / time	180°C, 2 minutes (220°C for Vocarb 3000)
Bake Time / temp	200°C, 12 minutes (230°C for Vocarb 3000)
Transfer line / valve temp	115°C

Table A-5
Surrogate and Internal Standard Concentrations

Standard	Components	Working Solution µg/mL	Spike amount µL (for 5 mL purge)	Final concentration µg/L (µg/kg)
Aromatic volatiles IS/SS	4-Chlorotoluene (SS) 1-Chloro-4-fluorobenzene (IS)	20 40	5	20 40
Halogenated volatiles IS/SS	4-chlorotoluene (SS) 1-Chloro-4-fluorobenzene (IS)	20 40	5	20 40
Combined Aromatic and halogenated volatiles IS/SS	Fluorobenzene (SS)	20	5	20
	1,4-Dichlorobutane (SS)	20	5	20
	1-Chloro-4-fluorobenzene (IS)	40	10	40

It may be necessary to select different surrogates in order to minimize sample interferences. 1-chloro-4-fluorobenzene and 4-chlorotoluene are fairly well resolved from analytes listed in this SOP. However 4-chlorotoluene may sometimes be requested as a target analyte. Other surrogates that may be considered, and issues associated with their use are:

Bromochloromethane: Elutes very close to chloroform and cis-1, 2-dichloroethene on the 502.2 column. May be a target analyte.

1,2-Bromochloroethane:

1-Chloro-2-fluorobenzene: Elutes close to ethylbenzene on DB-1 or Rtx-1 and close to m,p-xylene on 502.2

a,a,a-Trifluorotoluene: Good for aromatic volatiles, coelutes or very close to trichloroethene

Bromofluorobenzene: Close to 1,1,2,2-trichloroethane and 1,2,3-trichloropropane on the 502.2 column. Good on DB-1 or Rtx-1.

2-Bromo-1-chloropropane: May coelute with 1,1,2-trichloroethane

Table A-6
Concentrations for LCS and MS/MSD compounds

Standard	Components	Working Solution µg/mL	Spike amount µL (5 mL purge)	Final concentration µg/L (µg/kg)
Aromatic	Benzene	20	5	20
	Toluene	20		20
	Chlorobenzene	20		20
Halogenated	Chlorobenzene	20	5	20
	1,1-Dichloroethene	20		20
	Trichloroethene	20		20
Combination aromatic / halogenated	Benzene	20	5	20
	Toluene	20		20
	Chlorobenzene	20		20
	1,1-Dichloroethene	20		20
	Trichloroethene	20		20

1. SCOPE AND APPLICATION

This SOP Appendix describes procedures to be used when SW-846 Method 8081A is applied to the analysis of organochlorine pesticides by GC/ECD. This Appendix may also to be applied when discontinued SW-846 Method 8080A is requested, and is applicable to extracts derived from any matrix which are prepared according to the appropriate STL North Canton sample extraction SOPs. (CORP-OP-0001NC)

Table B-1 lists compounds, which are routinely determined by this method, and gives the Reporting Limits (RL) for each matrix. RLs given are based on the low level standard and the sample preparation concentration factors. Matrix interferences may result in higher RLs than those listed.

At client request, this method may also be used for the analysis of PCBs (Arochlors) in combination with pesticides, although these are normally analyzed following method 8082, as described in Appendix C of this SOP. In any event, if samples for PCB analysis do not need the acid clean up procedure, then the same injection may be used for method 8081B and 8082, assuming all calibration and QC requirements for both methods are met. Extracts that have been acid cleaned may not be analyzed for pesticides, since several of the pesticides will be degraded.

1.1. The associated LIMS method code is QJ (8081A).

2. SUMMARY OF METHOD

This method presents conditions for the analysis of prepared extracts of organochlorine pesticides. The pesticides are injected onto the column and separated and detected by electron capture detection. Quantitation may be by internal or external standard methods.

3. DEFINITIONS

Refer to the STL North Canton Laboratory Quality Manual (LQM), current version, for definitions of terms used in this document.

4. INTERFERENCES

4.1. Refer to the method 8000B section of this SOP for information regarding chromatographic interferences.

4.2. Interferences in the GC analysis arise from many compounds amenable to gas chromatography that give a measurable response on the electron capture detector. Phthalate esters, which are common plasticizers, can pose a major problem in the determinations. Avoiding contact with any plastic materials minimizes interferences from phthalates.

4.3. Sulfur will interfere and can be removed using procedures described in SOP CORP-OP-0001NC.

4.4. Interferences co-extracted from samples will vary considerably from source to source. The presence of interferences may raise quantitation limits for individual samples. Specific cleanups may be performed on the sample extracts, including florisil cleanup (Method 3620), Gel Permeation Chromatography (Method 3640), and Sulfur cleanup (Method 3660). These cleanup procedures are included in SOP # CORP-OP-0001NC. Using hexane / acetone as the extraction solvent (rather than hexane / methylene chloride) will reduce the amount of interferences extracted.

5. SAFETY

5.1. Refer to section 5 of the Method 8000B SOP for general safety requirements.

5.2. Aroclors have been classified as a potential carcinogen under OSHA. Concentrated solutions of Aroclors must be handled with extreme care to avoid excess exposure. Contaminated gloves and clothing must be removed immediately. Contaminated skin surfaces must be washed thoroughly.

5.3. The following parameters covered by this method have been tentatively classified as known or suspected, human or mammalian carcinogens: 4,4'-DDT, 4,4'-DDD, and the BHCs. Primary standards of these toxic compounds should be prepared in a hood.

5.4. All ^{63}Ni sources shall be leak tested every six months, or in accordance with the manufacturer's general radioactive material license.

5.5. All ^{63}Ni sources shall be inventoried every six months. If a detector is missing, the Director, EH&S shall be immediately notified and a letter sent to the NRC or local state agency.

6. EQUIPMENT AND SUPPLIES

6.1. Refer to Section 6 of the 8000B section of this SOP. A ^{63}Ni electron capture detector is required.

6.2. Refer to Table B-2 for analytical columns.

6.3. Microsyringes, various sizes, for standards preparation, sample injection, and extract dilution.

7. REAGENTS AND STANDARDS

7.1. Refer to the method 8000B section of this SOP for general requirements for reagents and supplies.

7.2. Refer to Table B-3 for details of calibration standards.

7.3. Surrogate Standards

Tetrachloro-m-xylene and decachlorobiphenyl are the surrogate standards. Refer to tables B-5 and B-6 for details of surrogate standards.

7.4. Column Degradation Evaluation Mix

A mid-level standard containing 4,4'-DDT and Endrin and not containing any of their breakdown products must be prepared for evaluation of degradation of these compounds by the GC column and injection port. This mix must be replaced after one year, or whenever corrective action to columns fails to eliminate the breakdown of the compounds, whichever is shorter. This solution also contains the surrogates. Refer to Table B-4 for details of the column degradation evaluation mix.

8. SAMPLE COLLECTION, PRESERVATION AND STORAGE

Refer to Section 8 of the 8000B section of this SOP.

9. QUALITY CONTROL

Refer to Section 9 of the 8000B section of this SOP.

10. CALIBRATION AND STANDARDIZATION

10.1. Refer to Section 10 of the 8000B section of this SOP for general calibration requirements.

10.2. Refer to Table B-2 for details of GC operating conditions. The conditions listed should result in resolution of all analytes listed in Table B-1 on both columns. Closely eluting pairs are DDE and Dieldrin on the Rtx-5 or DB-5 column and Endosulfan II and DDD on the 1701 column.

10.3. Column Degradation Evaluation

Before any calibration runs, either initial or 12 hour, The column evaluation mix must be injected before each initial or daily calibration. The degradation of DDT and endrin must be calculated (see equations 9 and 10) and each shown to be less than 15% before calibration can proceed. This is only necessary if the target compound list includes DDT, Endrin, or any of their degradation products.

If the breakdown of DDT and/or endrin exceeds the limits given above, corrective action must be taken. This action may include:

- Replacement of the injection port liner or the glass wool.
- Cutting off a portion of the injection end of a capillary column.
- Replacing the GC column.

10.4. Initial Calibration

Refer to Section 10 of the 8000B section of this SOP for details of calibration procedures.

10.4.1. Refer to Table B-7 for the initial calibration analytical sequence.

10.4.2. The response for each single-peak analyte will be calculated by the procedures described in the general method for GC analysis.

10.4.3. The surrogate calibration curve is calculated from the Individual AB mix. Surrogates in the other calibration standards are used only as retention time markers. If there are resolution problems, then the A and B mixes may be analyzed separately.

10.4.4. For multi-component pesticides:

Single point calibration is used for multi-component pesticides (typically toxaphene and technical chlordane). Two options are possible; the same quantitation option must be used for standards and samples. Refer to section 12.3 for guidance on which option to use.

10.4.5. For multi-component analytes, the mid level standard must be analyzed as part of the initial calibration. This single point calibration is used to quantitate multi-component analytes.

10.4.6. The analyst may include a full 5 point calibration for any of the multi-component analytes with the initial calibration.

10.5. 12 hour Calibration Verification

The 12 hour calibration verification sequence must be analyzed within 12 hours of the start of the initial calibration and at least once every 12 hours thereafter if samples are being analyzed. If more than 12 hours have elapsed since the injection of the last sample in the analytical sequence, a new analytical sequence must be started with a 12 hour calibration. A mid level calibration standard is used for the 12 hour calibration. Refer to the 8000B section of this SOP for acceptance criteria.

10.5.1. At a minimum, the 12 hour calibration includes analysis of the breakdown mix followed by mid level standards of any single and multi-component analytes.

10.5.2. The retention time windows for any analytes included in the 12 hour calibration are updated.

10.6. Continuing Calibration

The AB calibration mix is analyzed as the continuing calibration standard. At a minimum, this is analyzed after every 20 samples, including matrix spikes, LCS, and method blanks. If 12 hours elapse analyze the 12 hour standard sequence instead. The continuing calibration standard need not include multi-component analytes. If instrument drift is expected due to sample matrix or other factors, it may be advisable to analyze the continuing calibration standard more frequently.

10.6.1. A mid level calibration standard is used for the continuing calibration.

11. PROCEDURE

11.1. Refer to the method 8000B section of this SOP for general procedural requirements.

11.2. Extraction

The extraction procedure is described in SOP No. CORP-OP-0001NC.

11.3. Cleanup

Cleanup procedures are described in SOP No. CORP-OP-0001NC.

11.4. Suggested gas chromatographic conditions are given in Table B-2.

11.5. Allow extracts to warm to ambient temperature before injection.

11.6. The suggested analytical sequence is given in Table B-7.

12. DATA ANALYSIS AND CALCULATIONS

12.1. Refer to the 8000B section of this SOP for identification and quantitation of single component analytes.

12.2. Identification of Multi-component Analytes

Retention time windows are also used for identification of multi-component analytes, but the "fingerprint" produced by major peaks of those compounds in the standard is used in tandem with the retention times to identify the compounds. The ratios of the areas of the major peaks are also taken into consideration. Identification of these compounds may be made even if the retention times of the peaks in the sample fall outside of the retention time windows of the standard, if in the analyst's judgment the fingerprint (retention time and peak ratios) resembles the standard chromatogram.

12.3. Quantitation of Multi-component Analytes

Use 3-10 major peaks or total area for quantitation as described in section 10.4.4, initial calibration of multi-component analytes.

12.3.1. If there are no interfering peaks within the envelope of the multi-component analyte, the total area of the standards and samples may be used for quantitation. Any surrogate or extraneous peaks within the envelope must be subtracted from the total area.

12.3.1.1. Multiple peak option

This option is particularly valuable if toxaphene is identified but interferences make quantitation based on total area difficult. Select 3-10 major peaks in the analyte pattern. Calculate the response using the total area or total height of these peaks. Alternatively, find the response of each of the 3-10 peaks per multi-peak pesticide, and use these responses independently, averaging the resultant concentrations found in samples for a final concentration result. When using this option, it is appropriate to remove peaks that appear to be

coeluting with contaminant peaks from the quantitation. (i.e. peaks which are significantly larger than would be expected from the rest of the pattern.)

Chlordane may be quantitated either using the multiple peak option (12.3.1.1) total area option (12.3.1.2.) or by quantitation of the major components, α-chlordane, γ-chlordane and heptachlor.

12.3.1.2. Total area option

The total area of the standards and samples may be used for quantitation of multi-component analytes. Any surrogate or extraneous peaks within the envelope must be subtracted from the total area. This option should not be used if there are significant interference peaks within the multi-component pattern in the samples. The retention time window for total area measurement must contain at least 90% of the area of the analyte.

12.4. Second column confirmation multi-component analytes will only be performed when requested by the client, because the appearance of the multiple peaks in the sample usually serves as a confirmation of analyte presence.

12.5. Surrogate recovery results are calculated and reported for decachlorobiphenyl (DCB) and tetrachloro-m-xylene (TCMX). Corrective action is only necessary if DCB and TCMX are both outside of acceptance limits.

12.6. Calculation of Column Degradation/% Breakdown (%B)

Equation 9

$$DDT\ \%B = \frac{A_{DDD} + A_{DDE}}{A_{DDD} + A_{DDE} + A_{DDT}} \times 100$$

where:
A_{DDD}, A_{DDE}, and A_{DDT} = the response of the peaks for 4,4'-DDD, 4,4'-DDE, and 4,4'-DDT in the column degradation evaluation mix.

Equation 10

$$Endrin\ \%B = \frac{A_{EK} + A_{EA}}{A_{EK} + A_{EA} + A_{E}} \times 100$$

where:
A_{EK}, A_{EA}, and A_{E} = the response of endrin ketone, endrin aldehyde, and endrin in the column degradation evaluation mix.

13. METHOD PERFORMANCE

13.1. Performance limits for the four replicate initial demonstration of capability required under Section 13.1 of the main body of this SOP. Example performance limits are listed in Table B-8. The spiking level should be equivalent to a mid level calibration.

14. POLLUTION PREVENTION

Refer to section 14 of the 8000B section of this SOP.

15. WASTE MANAGEMENT

15.1. Waste generated in this procedure will be segregated and disposed according to the facility hazardous waste procedures. The Environmental Health and Safety Director should be contacted if additional information is required.

16. REFERENCES

16.1. SW846, Update III, December 1996, Method 8081A

17. MISCELLANEOUS

17.1. Modifications from Reference Method

None

17.2. Modifications from Previous Revisions

17.2.1. No revisions were made to this appendix.

17.3. Tables

Table B-1
Standard Analyte list and Reporting Limits

Compound	Reporting Limit, µg/L or µg/kg		
	water	soil	waste
Aldrin	0.05	1.7	50
α-BHC	0.05	1.7	50
β-BHC	0.05	1.7	50
δ-BHC	0.05	1.7	50
γ-BHC (Lindane)	0.05	1.7	50
α-Chlordane	0.05	1.7	50
γ-Chlordane	0.05	1.7	50
Chlordane (technical)	0.5	17	500
4,4'-DDD	0.05	1.7	50
4,4'-DDE	0.05	1.7	50
4,4'-DDT	0.05	1.7	50
Dieldrin	0.05	1.7	50
Endosulfan I	0.05	1.7	50
Endosulfan II	0.05	1.7	50
Endosulfan Sulfate	0.05	1.7	50
Endrin	0.05	1.7	50
Endrin Aldehyde	0.05	1.7	50
Heptachlor	0.05	1.7	50
Heptachlor Epoxide	0.05	1.7	50
Methoxychlor	0.1	3.3	100
Toxaphene	2.0	67	2000
APPENDIX IX ADD ONs			
Diallate	1.0	33	1000
Isodrin	0.1	3.3	100
Chlorobenzilate	0.1	3.3	100
Kepone[1]	1.0	33	1000

[1] Kepone is sometimes requested for analysis by method 8081A. However kepone may produce peaks with broad tails that elute later than the standard by up to a minute (presumably due to hemi-acetal formation). As a result kepone analysis by 8081A is unreliable and not recommended. Analysis by method 8270C is a possible alternative. Note: alpha chlordane, gamma chlordane, and endrin ketone are not required for some projects.

The following concentration factors are assumed in calculating the Reporting Limits:

	Extraction Vol.	Final Vol.
Ground water	1000 mL	10 mL
Low-level Soil	30 g	10 mL
High-level soil / waste	1 g	10 mL

Table B-2	
Parameter	**Recommended Conditions**
Injection port temp	220°C
Detector temp	325°C
Temperature program	120°C for 1 min, 8.5°C/min to 285°C, , 6 min hold
Column 1	Rtx-CLPesticides 30m x 0.32mm id, 0.5µm
Column 2	Rtx-35 30m x 0.32 mm id, 0.5µm
Column 3	DB-608, 30m X 0.32 mm, 0.25µm
Injection	2µL
Carrier gas	Helium or Hydrogen
Make up gas	Nitrogen
Y splitter	Restek or J&W or Supelco glass tee

Table B-3						
Calibration Levels ng/mL						
	Level 1	Level 2	Level 3	Level 4	Level 5	Level 6[2]
Individual Mix AB[1]						
Aldrin	5	10	25	50	100	200
g-BHC (Lindane)	5	10	25	50	100	200
Heptachlor	5	10	25	50	100	200
Methoxychlor	10	20	50	100	200	400
Dieldrin	5	10	25	50	100	200
Endosulfan I	5	10	25	50	100	200
Endosulfan II	5	10	25	50	100	200
4,4'-DDT	5	10	25	50	100	200
Endrin Aldehyde	5	10	25	50	100	200
Endrin Ketone	5	10	25	50	100	200
β-BHC	5	10	25	50	100	200
δ-BHC	5	10	25	50	100	200
α-BHC	5	10	25	50	100	200
4,4'-DDD	5	10	25	50	100	200
4,4'-DDE	5	10	25	50	100	200
Endosulfan Sulfate	5	10	25	50	100	200
Endrin	5	10	25	50	100	200
α-Chlordane [3]	5	10	25	50	100	200
γ-Chlordane [3]	5	10	25	50	100	200
Multi-component Standards						
Chlordane (Technical)			250[4]			
Toxaphene			1000[5]			
Surrogates are included with all the calibration mixes at the following levels:						
Tetrachloro-m-xylene	5	10	25	50	100	200
Decachlorobiphenyl	5	10	25	50	100	200

[1] Standards may be split into an A and B mix if resolution of all compounds on both columns is not obtained.
[2] Level 6 is optional and should only be used if linearity can be maintained on the instrument to this level.
[3] Compounds may be used in lieu of running a daily technical Chlordane standard for samples that are non-detect for technical Chlordane.
[4] This standard may be used for quantitation of technical chlordane between 50 and 1000 ng/mL. If the chlordane is more concentrated, the extract must be diluted and reanalyzed.
[5] This standard may be used for quantitation of toxaphene between 200 and 4000 ng/mL. If the toxaphene is more concentrated, the extract must be diluted and reanalyzed.

Table B-4	
Column Degradation Evaluation Mix ng/mL	
Component	Concentration
4,4'-DDT	25
Endrin	25
Tetrachloro-m-xylene (Surrogate)	20
Decachlorobiphenyl (Surrogate)	20

Table B-5			
LCS/Matrix Spike and Surrogate Spike levels mg/L or mg/kg			
	Aqueous	Soil	Waste
gamma BHC (Lindane)	0.20	33.3	200
Aldrin	0.20	33.3	200
Heptachlor	0.20	33.3	200
Dieldrin	0.50	33.3	500
Endrin	0.50	33.3	500
4,4'DDT	0.50	33.3	500
Tetrachloro-m-xylene (Surrogate)	0.20	33.3	200
Decachlorobiphenyl (Surrogate)	0.20	33.3	200

Table B-6		
LCS/Matrix Spike and Surrogate Spike levels for TCLP mg/L or mg/kg		
	Aqueous	Waste
Heptachlor	5	500
Heptachlor epoxide	5	500
Lindane	5	500
Endrin	5	500
Methoxychlor	10	1000

Table B-7
Suggested Analytical Sequence

Initial Calibration

Solvent blank (optional)	
Breakdown Mix	
Individual mix AB	All levels
Technical Chlordane	Level 3[1]
Toxaphene	Level 3[1]
Up to 20 samples unless 12 hours comes first)	
Solvent blank (optional)	
Individual mix AB	Mid level (Continuing calibration)
Samples	
After 12 hours:	
Breakdown mix	
Individual mix AB	
Any other single component analytes	

Any multi-component analytes

[1] A five point curve for any of the multi-component analytes may be included
If Arochlors are included, a 5 point calibration for Arochlor 1016/1260 should be included with the initial calibration and a single point for the other Arochlors. The mid point 1016/1260 mix is included with the daily calibration (every 12 hours).

Note: A solvent blank or primer may be analyzed at any time during the sequence when highly contaminated samples are expected. A solvent blank or primer may not be analyzed as routine immediately prior to standards.

12 hour Calibration

At least every 12 hours, counting from the start of the initial calibration, or from the start of the last daily calibration, the retention time windows must be updated using the Individual mix AB, and the breakdown mix must be run before the continuing calibration.

Table B-8		
Example Performance limits, four replicate initial demonstration of capability		
Compound	Initial demonstration, mean recovery limits	Initial demonstration, RSD limits
Aldrin	46-112	21
alpha-BHC	51-122	24
beta-BHC	61-120	32
delta-BHC	49.5-118.5	36
gamma-BHC	57-116	23
Chlordane	44.8-108.6	20
4,4'-DDD	52-126	28
4,4'-DDE	46-120	27.5
4,4'-DDT	54-137	36
Dieldrin	42.5-124.5	38
Endosulfan I	43-141	24.5
Endosulfan II	78-171	61
Endosulfan Sulfate	62-132	27
Endrin	49-126	37
Heptachlor	57-100	20
Heptachlor Epoxide	43.5-131.5	25.4
Toxaphene	44.4-111.2	20

1. SCOPE AND APPLICATION

1.1. This SOP Appendix describes procedures to be used when SW-846 Method 8000B is applied to the analysis of polychlorinated biphenyls (PCB) by GC/ECD. This Appendix is to be applied when SW-846 Method 8082 is requested, and is applicable to extracts derived from any matrix which are prepared according to the appropriate STL sample extraction SOPs. (CORP-OP-0001NC). The PCBs are determined and quantitated as Arochlor mixes.

1.2. Table C-1 lists compounds, which are routinely determined by this method, and gives the Reporting Limits (RL) for each matrix. RLs given are based on the low level standard and the sample preparation concentration factors. Matrix interferences may result in higher RLs than those listed.

Note: SW-846 method 8082 provides incomplete guidance for determination of individual PCB congeners. This SOP does not include directions for congener specific analysis.

1.3. The associated LIMS method code is QH (8082).

2. SUMMARY OF METHOD

This method presents conditions for the analysis of prepared extracts of PCBs. The PCBs are injected onto the column and separated and detected by electron capture detection. Quantitation is by the external standard method.

3. DEFINITIONS

Refer to the STL North Canton Laboratory Quality Manual (LQM), current version, for definitions of terms used in this document.

4. INTERFERENCES

4.1. Refer to the method 8000B section of this SOP for information regarding chromatographic interferences.

4.2. Interferences in the GC analysis arise from many compounds amenable to gas chromatography that give a measurable response on the electron capture detector. Phthalate esters, which are common plasticizers, can pose a major problem in the determinations. Avoiding contact with any plastic materials minimizes interferences from phthalates.

4.3. Sulfur will interfere and can be removed using procedures described in SOP CORP-OP-0001NC.

4.4. Interferences co-extracted from samples will vary considerably from source to source. The presence of interferences may raise quantitation limits for individual samples. Specific cleanups may be performed on the sample extracts, including florisil cleanup (Method 3620), Gel Permeation Chromatography (Method 3640), and Sulfur cleanup (Method 3660). These cleanup procedures are included in SOP # CORP-OP-0001NC.

5. SAFETY

5.1. Refer to section 5 of the Method 8000B SOP for general safety requirements.

5.2. Aroclors have been classified as a potential carcinogen under OSHA. Concentrated solutions of Aroclors must be handled with extreme care to avoid excess exposure. Contaminated gloves and clothing must be removed immediately. Contaminated skin surfaces must be washed thoroughly.

5.3. All ^{63}Ni sources shall be leak tested every six months, or in accordance with the manufacturer's general radioactive material license.

5.4. All ^{63}Ni sources shall be inventoried every six months. If a detector is missing, the Director, EH&S shall be immediately notified and a letter sent to the NRC or local state agency.

6. EQUIPMENT AND SUPPLIES

6.1. Refer to Section 6 of the 8000B section of this SOP. A ^{63}Ni electron capture detector is required.

6.2. Refer to Table C-2 for analytical columns.

6.3. Microsyringes, various sizes, for standards preparation, sample injection, and extract dilution.

7. REAGENTS AND STANDARDS

7.1. Refer to the method 8000B section of this SOP for general requirements for reagents and supplies. The standards must be replaced at least every six months or sooner if comparison with check standards indicates a problem.

7.2. Refer to Table C-3 for details of calibration standards.

7.3. Surrogate Standards

Tetrachloro-m-xylene and decachlorobiphenyl are the surrogate standards. Other surrogates may be used at client request. Refer to Table C-4 for details of surrogate standards.

8. SAMPLE COLLECTION, PRESERVATION AND STORAGE

Refer to Section 8 of the 8000B section of this SOP.

9. QUALITY CONTROL

Refer to Section 9 of the 8000B section of this SOP.

10. CALIBRATION AND STANDARDIZATION

10.1. Refer to Section 10 of the 8000B section of this SOP for general calibration requirements.

10.2. Initial Calibration

10.2.1. Refer to Table C-5 for the initial calibration analytical sequence.

10.2.2. The response for each Arochlor will be calculated by the procedures described in the general method for GC analysis, with the following modifications.

10.2.3. A five point calibration of the Arochlor 1016/1260 mix is generated with at least mid level single points for the other Aroclor mixes. The average response factor is used to quantitate Arochlors 1260 and 1016, other Arochlors are quantitated from the mid level single point.

10.2.4. The analyst may include a full 5 point calibration for any of the Arochlors with the initial calibration.

10.2.5. The high and low standards for the initial 5 point calibration of 1016 / 1260 define the acceptable quantitation range for the other Arochlors. If any Arochlor is determined above this concentration the extract must be diluted and reanalyzed.

10.2.6. If the analyst knows that a specific Arochlor is of interest for a particular project, that Arochlor may be used for the five point calibration rather than the 1016 / 1260 mix.

10.2.7. The surrogate calibration curve is calculated from the Aroclor 1016/1260 mix. Surrogates in the other calibration standards are used only as retention time markers.

10.2.8. Two options are possible for quantitation of Aroclors. The same quantitation option must be used for standards and samples.

10.2.8.1. Multiple peak option

Select 3-10 major peaks in the analyte pattern. Calculate the response using the total area or total height of these peaks. Alternatively, find the response of each of the 3-10 peaks per Aroclor, and use these responses independently, averaging the resultant concentrations found in samples for a final concentration result. When using this option, it is appropriate to remove peaks that appear to be coeluting with contaminant peaks from the quantitation. (i.e. peaks which are significantly larger than would be expected from the rest of the pattern.)

10.2.8.2. Total area option

The total area of the standards and samples may be used for quantitation of multi-component analytes. Any surrogate or extraneous peaks within the envelope must be subtracted from the total area. This option should not be used if there are significant interference peaks within the multi-component pattern in the samples. The retention time window for total area measurement must contain at least 90% of the area of the analyte.

10.3. 12 hour Calibration

The 12 hour calibration verification must be analyzed within 12 hours of the start of the initial calibration and at least once every 12 hours thereafter if samples are being analyzed. If there is a break in the analytical sequence of greater than 12 hours, then a new continuing calibration run must be analyzed before proceeding with the sequence. If more than 12 hours have elapsed since the injection of the last sample in the analytical sequence, a new analytical sequence must be started with a 12 hour calibration.

10.3.1. At a minimum, the 12 hour calibration includes analysis of the Arochlor 1260 / 1016 mix.

10.3.2. It is adequate to verify calibration with a mixture of Aroclors 1016 and 1260. If a specific Aroclor is expected, it may be included in the daily calibration check.

10.3.3. The retention time windows for any analytes included in the daily calibration and CCVs are updated.

10.3.4. For this method samples must be bracketed with successful calibration verification runs.

10.4. Calibration verification

The Arochlor 1260/1016 calibration mix is analyzed as the calibration verification standard. This is analyzed after every 20 samples, including matrix spikes, LCS, and method blanks. (Depending on the type of samples, it may be advisable to analyze verifications more frequently in order to minimize reruns.).

10.4.1. A mid level standard is used for the calibration verification.

11. PROCEDURE

11.1. Refer to the method 8000B section of this SOP for general procedural requirements.

11.2. Extraction

The extraction procedure is described in SOP No. CORP-OP-0001NC.

11.3. Cleanup

Cleanup procedures are described in SOP No. CORP-OP-0001NC.

11.4. Suggested gas chromatographic conditions are given in Table C-2.

11.5. Allow extracts to warm to ambient temperature before injection.

11.6. The suggested analytical sequence is given in Table C-5.

12. DATA ANALYSIS AND CALCULATIONS

12.1. Identification of Arochlors

Retention time windows are used for identification of Arochlors, but the "fingerprint" produced by major peaks of those analytes in the standard is used in tandem with the retention times for identification. The ratios of the areas of the major peaks are also taken into consideration. Identification may be made even if the retention times of the peaks in the sample fall outside of the retention time windows of the standard, if in the analyst's judgment the fingerprint (retention time and peak ratios) resembles the standard chromatogram.

A clearly identifiable Arochlor pattern serves as confirmation of single column GC analysis. Dual column confirmation may be used for specific program requirements or by client request.

12.2. Quantitation of Arochlors

Use 3-10 major peaks or total area for quantitation

If the analyst believes that a combination of Aroclor 1254 and 1260, or a combination of 1242, 1248 and 1232 is present, then only the predominant Arochlor is quantitated and reported, but the suspicion of multiple Aroclors is discussed in the narrative. If well separated Aroclor patterns are present, and then both Aroclors are quantitated and reported.

12.3. If there are no interfering peaks within the envelope of the Arochlor, the total area of the standards and samples may be used for quantitation. Any surrogate or extraneous peaks within the envelope must be subtracted from the total area.

12.4. Second column confirmation of Aroclors will only be performed when requested by the client. The appearance of the multiple peaks in the sample usually serves as a confirmation of Aroclor presence.

12.5. Surrogate recovery results are calculated and reported for decachlorobiphenyl (DCB) and tetrachloro-m-xylene (TCMX). Corrective action is only necessary if DCB and TCMX are both outside of acceptance limits.

13. METHOD PERFORMANCE

13.1. Performance limits for the four replicate initial demonstration of capability are required as referenced under Section 13.1 of the main body of this SOP.

13.2. Method detection limits (MDL) are determined for all Arochlors.

14. POLLUTION PREVENTION

Refer to section 14 of the 8000B section of this SOP.

15. WASTE MANAGEMENT

15.1. Waste generated in this procedure will be segregated and disposed according to the facility hazardous waste procedures. The Environmental Health and Safety Director should be contacted if additional information is required.

16. REFERENCES

16.1. SW846, Update III, December 1996, Method 8082

17. MISCELLANEOUS

17.1. Modifications from Reference Method

17.1.1. Method 8082 includes limited direction for congener specific quantitation. This is outside the scope of this SOP.

17.2. Modifications from Previous Revisions

No changes were made to this Appendix

17.3. Tables

Table C-1
Standard Analyte list and Reporting Limits

Compound	Reporting Limit, µg/L or µg/kg		
	water	soil	waste
Aroclor-1016	1.0	33	1000
Aroclor-1221	1.0	33	1000
Aroclor-1232	1.0	33	1000
Aroclor 1242	1.0	33	1000
Aroclor-1248	1.0	33	1000
Aroclor-1254	1.0	33	1000
Aroclor-1260	1.0	33	1000

The following concentration factors are assumed in calculating the Reporting Limits:

	Extraction Vol.	Final Vol.
Ground water	1000 mL	10 mL
Low-level Soil	30 g	10 mL
High-level soil / waste	1 g	10 mL

Table C-2

Parameter	Recommended Conditions
Injection port temp	220°C
Detector temp	325°C
Temperature program	70°C for 0.5min, 30°C/min to 190°C, 2.5°C/min to 225, 18°C/min to 280°C, 3 min hold
Column 1	DB-5 or Rtx-5 30m x 0.32mm id, 0.5µm
Column 2	DB-1701 or Rtx 1701 30m x 0.32 mm id, 0.25µm
Column 3	DB-608, 30m X 0.32 mm, 0.25µm
Injection	1-2µL
Carrier gas	Helium or Hydrogen
Make up gas	Nitrogen
Y splitter	Restek or J&W or Supelco glass tee

Table C-3						
Calibration Levels ng/mL						
	Level 1	Level 2	Level 3	Level 4	Level 5	Level 6[1]
Aroclor 1016/1260	100	200	500	1000	2000	4000
Aroclor 1242[2]			500			
Aroclor 1221 +1254[2]			500			
Aroclor 1232[2]			500			
Aroclor 1248[2]			500			
Surrogates are included with all the calibration mixes at the following levels:						
Tetrachloro-m-xylene	5	10	25	50	100	200
Decachlorobiphenyl	5	10	25	50	100	200

[1] Level 6 is optional and should only be used if linearity can be maintained on the instrument to this level.
[2] Aroclors may be quantitated within the range 100 to 2000 ng/mL (4000ng/mL if the level 6 1016/1260 standard is included). If the Aroclor is more concentrated, it must be reanalyzed at a dilution.

Table C-4			
LCS/Matrix Spike and Surrogate Spike levels for Aroclor analysis with Acid Cleanup mg/L or mg/kg			
	Aqueous	Soil	Waste
Aroclor 1016/1260	10	333	10,000
Tetrachloro-m-xylene (Surrogate)	0.20	6.67	200
Decachlorobiphenyl (Surrogate)	0.20	6.67	200

Table C-5 **Michigan Analyte List and Reporting Limits[1]**			
	Reporting Limit		
Compound	water (µg/L)	soil (µg/Kg)	
Aroclor-1016	0.2	330	
Aroclor-1221	0.2	330	
Aroclor-1232	0.4	330	
Aroclor 1242	0.2	330	
Aroclor-1248	0.2	330	
Aroclor-1254	0.2	330	
Aroclor-1260	0.2	330	

[1] Reporting Limits are only for samples performed under the Michigan program

Table C-5
Suggested Analytical Sequence

Initial Calibration

Injection #		
1	Solvent blank (optional)	
2	Aroclor 1016/1260	Level 1
3	Aroclor 1016/1260	Level 2
4	Aroclor 1016/1260	Level 3
5	Aroclor 1016/1260	Level 4
6	Aroclor 1016/1260	Level 5
7	Aroclor 1232	Level 3
8	Aroclor 1242	Level 3
9	Aroclor 1248	Level 3
10	Aroclor 1221/1254	Level 3
11-30	Sample 1-20 (or as many samples as can be analyzed in 12 hours	
	Solvent blank (optional)	
32	Aroclor 1016/1260	Level 3

etc

Note: A solvent blank or primer may be analyzed at any time during the sequence when highly contaminated samples are expected. A solvent blank or primer may not be analyzed as routine immediately prior to standards.

12 hour Calibration

At least every 12 hours, counting from the start of the initial calibration, or from the start of the last daily calibration, the retention time windows must be updated using the Aroclor 1260 / 1016 mix. Mid level standards of any other Aroclors expected to be present in the samples are also injected.

1. SCOPE AND APPLICATION

This method is applicable to the gas chromatographic determination of Chlorinated phenoxy acid herbicides in extracts prepared by SOP CORP-OP-0001NC. The herbicides listed in Table D1 are routinely analyzed. Other chlorinated acids may be analyzed by this method if the quality control criteria in Section 9 and the initial demonstration of method performance in Section 13 are met.

1.1. The associated LIMS method code is QS.

2. SUMMARY OF METHOD

This method presents conditions for the analysis of prepared extracts of phenoxy acid herbicides by gas chromatography. The herbicides, as their methyl esters, are injected onto the column, separated, and detected by electron capture detectors. Quantitation is by the external standard method.

3. DEFINITIONS

Refer to the STL North Canton Laboratory Quality Manual (LQM), current version, for definitions of terms used in this document.

4. INTERFERENCES

4.1. Refer to the method 8000B section of this SOP for general information regarding chromatographic interferences.

4.2. Chlorinated acids and phenols cause the most direct interference with this method.

4.3. Sulfur may interfere and may be removed by the procedure described in SOP#CORP-OP-0001NC.

5. SAFETY

5.1. Refer to section 5 of the Method 8000B SOP for general safety requirements.

6. EQUIPMENT AND SUPPLIES

6.1. Refer to Section 6 of the 8000B section of this SOP. A Ni_{63} electron capture detector is required.

6.2. Refer to Table D2 for analytical columns.

6.3. Microsyringes, various sizes, for standards preparation, sample injection, and extract dilution.

7. REAGENTS AND STANDARDS

7.1. Refer to section 7 of the 8000B section of this SOP for general information on reagents and standards.

8. SAMPLE PREPARATION, PRESERVATION AND STORAGE

Refer to Section 8 of the 8000B section of this SOP.

9. QUALITY CONTROL

9.1. Refer to Section 9 of the 8000B section of this SOP for quality control requirements, including the initial demonstration of capability, definition of a batch, surrogate limits, method blanks, laboratory control samples (LCS), and matrix spikes (MS).

9.2. Refer to Table D-3 for the components and levels of the LCS and MS mixes.

10. CALIBRATION AND STANDARDIZATION

10.1. Refer to Section 10 of the 8000B section of this SOP for general calibration requirements.

10.2. Calibration standards are prepared from purchased standards in the methyl ester form.

10.3. The low level standard must be at or below the laboratory reporting limit. Other standards are chosen to bracket the expected range of concentrations found in samples, without saturating the detector or leading to excessive carryover.

10.4. Refer to Table D-2, for details of GC operating conditions.

11. PROCEDURE

11.1. Refer to the method 8000B section of this SOP for procedural requirements.

11.2. Extraction

The extraction procedure is described in SOP #CORP-OP-0001NC.

11.3. Cleanup

The alkaline hydrolysis and subsequent extraction of the basic solution described in the extraction procedure provides an effective cleanup.

11.4. Analytical Sequence

The analytical sequence starts with an initial calibration of at least five points, or a daily calibration that meets % difference criteria from an existing initial calibration.

11.4.1. The daily calibration must be analyzed at least once every 24 hours when samples are being analyzed. If there is a break in the analytical sequence of greater than 12 hours, then a new continuing calibration run must be analyzed before proceeding with the sequence. If more than 24 hours have elapsed since the injection of the last sample in the analytical sequence, a new analytical sequence must be started with a daily calibration.

11.4.2. The daily calibration consists of mid level standards of all analytes of interest. Retention time windows must be updated with the daily calibration.

11.4.3. After every 12 hours a continuing calibration is analyzed. The continuing calibration consists of mid level standards of all analytes of interest. Retention time windows are updated with continuing calibrations.

11.5. Gas Chromatography

Chromatographic conditions are listed in Table D-2.

12. DATA ANALYSIS AND CALCULATIONS

12.1. Refer to the 8000B section of this SOP for identification and quantitation of single component analytes.

12.2. The herbicides are analyzed as their methyl esters, but reported as the free acid. For this reason it is necessary to correct the results for the molecular weight of the ester versus the free acid. This is achieved through the concentrations of the calibration standards. For example the 20µg/L calibration standard for 2,4-D contains 21.3 µg/L of the methyl ester. No further correction is necessary.

12.3. A routine 10X dilution occurs on final extracts for all samples. Due to a QuantIMS limitation, the dilution factor field in QuantIMS cannot be used when a dilution is routine, because the dilution factor is automatically applied to all reference values creating reporting problems. For the herbicide analysis, the extract volume will be 10mL and an aliquot at 10X dilution will be analyzed. The final extract volume recorded on the laboratory bench sheet will be recorded as 100mL to avoid using the dilution factor field in QuantIMS.

13. METHOD PERFORMANCE

13.1. The EPA for this method has not published multiple laboratory performance data. Performance limits for the four replicate initial demonstration of capability are required as referenced under Section 13.1 of the main body of this SOP.

14. POLLUTION PREVENTION

This method does not contain any specific modifications that serve to minimize or prevent pollution.

15. WASTE MANAGEMENT

Waste generated in this procedure will be segregated and disposed according to the facility hazardous waste procedures. The Environmental Health and Safety Director should be contacted if additional information is required.

16. REFERENCES

Method 8151A, SW-846, Update III, December 1996

17. MISCELLANEOUS

17.1. Modifications from Reference Method

Refer to the method 8000B section of this SOP for modifications from the reference method.

17.2. Modifications from Previous Revision

The calibration procedure has been changed to require esterification of the calibration standards

17.3. Tables

Table D-1				
Standard Analyte list				
Compound	CAS Number	Reporting Limit, µg/L or µg/kg		
		Aqueous	Soil	Waste
2,4-D	94-75-7	4	80	4000
2,4-DB	94-82-6	4	80	4000
2,4,5-TP (Silvex)	93-72-1	1	20	1000
2,4,5-T	93-76-5	1	20	1000
Dalapon	75-99-0	2	40	2000
Dicamba	1918-00-9	2	40	2000
Dichloroprop	120-36-5	4	80	4000
Dinoseb	88-85-7	0.6	12	600
MCPA	94-74-6	400	8000	400,000
MCPP	93-65-2	400	8000	400,000

The following concentration factors are assumed in calculating the Reporting Limits:

	Extraction Vol.	Final Vol.	Dilution Factor
Ground water	1000 mL 10 mL	20	
Low-level Soil without GPC	50 g	10 mL	20
High-level soil / waste	1 g	10 mL	20

Specific reporting limits are highly matrix dependent. The reporting limits listed above are provided for guidance only and may not always be achievable. For special projects, the extracts may be analyzed without any dilution, resulting in reporting limits 20 times lower than those in Table D-1.

Table D-2	
Instrumental Conditions	
PARAMETER	Recommended conditions
Injection port temp	220°C
Detector temp	325°C
Temperature program	80,2/30/170,0/1/180,1
Column 1	DB-5MS or RTX 5 30x0.32, 0.5um
Column 2	DB-1701 or Rtx-1701
Injection	1-2µL
Carrier gas	Helium / Hydrogen
Make up gas	Nitrogen

Recommended conditions should result in resolution of all analytes listed in Table D-1.

The reporting limits listed in Table D-1 will be achieved with these calibration levels and a 20 fold dilution of the sample extract. Lower reporting limits can be achieved with lesser dilutions of the sample extract.

Table D-3			
LCS/Matrix Spike and Surrogate Spike levels mg/L or mg/kg[1]			
	Aqueous	Soil	Waste
2,4-D	16	800	16000
Silvex	4	200	4000
2,4,5-T	4	200	4000
2,4-DB	16	800	16000
Dalapon	8	400	8000
DCAA (surrogate)	16	800	16000

[1] LCS, MS and SS spikes are as the free acid.

1. SCOPE AND APPLICATION

1.1. This method is applicable to the determination of the concentration of certain Organophosphorus Pesticides in waters, wastewaters, oils, soils, and sludges. It is based on SW846 Method 8141A. Table E1 shows reporting limits for compounds routinely analyzed by this method. The compounds include, but are not limited to, those shown in Table E1.

1.2. This document accurately reflects current laboratory standard operating procedures (SOP) as of the date above. All facility SOPs are maintained and updated as necessary by the laboratory QA department.

1.3. The associated LIMS method code is P2.

2. SUMMARY OF METHOD

2.1. An aliquot of prepared sample is injected in a gas chromatograph (GC) and compounds in the effluent are detected by a flame photometric detector. Appropriate preparation techniques are described in SOP CORP-OP-0001NC. Ultrasonic Extraction (Method 3550) is **NOT** an appropriate sample preparation for Method 8141 and should not be used because of the potential for destruction of target analytes during the ultrasonic extraction process.

3. DEFINITIONS

Refer to the STL North Canton Laboratory Quality Manual (LQM), current version, for definitions of terms used in this document.

4. INTERFERENCES

4.1. Refer to the method 8000B section of this SOP for general information regarding chromatographic interferences.

4.2. Analytical difficulties encountered for target analysis include:

4.2.1. The water solubility of Dichlorvos (DDVP) is 10 g/L at 20°C, and recovery is poor from aqueous solution.

4.2.2. Naled is converted to Dichlorvos (DDVP) on column by debromination. This reaction may also occur during sample workup.

4.2.3. Trichlorfon rearranges and is dehydrochlorinated in acidic, neutral, or basic media to form Dichlorvos (DDVP) and hydrochloric acid. If this method is to be used for the determination of organophosphates in the presence of Trichlorfon, the analyst should be aware of the possibility of rearrangement to Dichlorvos to prevent misidentification.

4.2.4. Merphos is a single component pesticide that is readily oxidized to Merphos oxone. Chromatographic analysis of Merphos almost always results in two peaks.

5. SAFETY

5.1. Refer to Section 5 of the Method 8000B SOP for general safety requirements.

6. EQUIPMENT AND SUPPLIES

6.1. Refer to Section 6 of the 8000B section of this SOP.

6.2. Refer to Table E2 for Instrument settings.

6.3. Microsyringes, various sizes, for standards preparation, sample injection, and extract dilution.

7. REAGENTS AND STANDARDS

7.1. Refer to Section 7 of the 8000B section of this SOP for general information on reagents and standards.

7.2. Refer to Table E-3 for details of calibration and other standards.

7.3. Surrogate Standards

Triphenyl phosphate is the surrogate standard. Refer to Table E-4 for details of the surrogate standard.

8. SAMPLE PREPARATION, PRESERVATION AND STORAGE

Refer to section 8 of the 8000B section of this SOP.

9. QUALITY CONTROL

9.1. Refer to Section 9 of the 8000B section of this SOP for quality control requirements, including the initial demonstration of capability, definition of a batch, surrogate limits, method blanks, laboratory control samples (LCS), and matrix spikes (MS).

9.2. Refer to Table E-4 for the components and levels of the LCS and MS mixes.

10. CALIBRATION AND STANDARDIZATION

10.1. Refer to Section 10 of the 8000B section of this SOP for general calibration requirements.

10.2. Calibration standards are made up from purchased solutions. Table E-3 lists the calibration levels.

10.3. The low level standard must be at or below the laboratory reporting limit. Other standards are chosen to bracket the expected range of concentrations found in samples, without saturating the detector or leading to excessive carryover.

11. PROCEDURE

11.1. Refer to the method 8000B section of this SOP for procedural requirements.

11.2. Extraction

The extraction procedure is described in SOP #CORP-OP-0001NC.

11.3. Cleanup

11.4. Analytical Sequence

The analytical sequence starts with an initial calibration of at least five points, or a daily calibration that meets % difference criteria from an existing initial calibration.

11.4.1. The daily calibration must be analyzed at least once every 24 hours when samples are being analyzed. If there is a break in the analytical sequence of greater than 12 hours, then a new continuing calibration run must be analyzed before proceeding with the sequence. If more than 24 hours have elapsed since the injection of the last sample in the analytical sequence, a new analytical sequence must be started with a daily calibration.

11.4.2. The daily calibration consists of mid level standards of all analytes of interest. Retention time windows must be updated with the daily calibration.

11.4.3. After every 12 hours a continuing calibration is analyzed. The continuing calibration consists of mid level standards of all analytes of interest. Retention time windows are updated with continuing calibrations.

12. DATA ANALYSIS AND CALCULATIONS

12.1. Refer to the 8000B section of this SOP for identification and quantitation of single component analytes.

12.2. Surrogate recovery results are calculated and reported for Triphenylphosphate unless it is determined that sample interference has adversely affected the quantitation of one of the surrogates. The surrogate must be within QC criteria. Corrective action is only necessary if Triphenylphosphate is outside of acceptance limits.

13. METHOD PERFORMANCE

13.1. Performance limits for the four replicate initial demonstration of capability are required as referenced under Section 13.1 of the main body of this SOP.

14. POLLUTION PREVENTION

Refer to section 14 of the 8000B section of this SOP.

15. WASTE MANAGEMENT

15.1. Waste generated in this procedure will be segregated and disposed according to the facility hazardous waste procedures. The Environmental Health and Safety Director should be contacted if additional information is required.

16. REFERENCES

SW846, Update III, December 1996, Method 8141A.

17. MISCELLANEOUS

17.1. Reporting limits

17.1.1. The lower standard reporting limits are listed in Table E-1

17.1.2. If samples require dilution or smaller volumes than specified in this method, the RL will be elevated.

17.1.2.1. The nature of the FPD detector contributes to high dilutions for Method 8141A. There is a phenomenon known as quenching that occurs. This happens when light absorption occurs in the flame of the FPD due to hydrocarbons, sulfur, and certain light absorbing compounds. When this happens the analytes of interest do not reach the photomultiplier tube and are not detected even though they may be present.

17.2. Elution time

17.2.1. For any positive detection in a sample, the chromatogram is overlaid on screen with the nearest standard for elution time matching and pattern recognition using the Target system.

17.3. Troubleshooting guide

17.3.1. Consult the instrument manufacturer's operating manual for guidance.

Table E1: Organophosphorus Pesticides Routinely Analyzed and Reporting Limits

Compound	CAS Number	Reporting Limits	
		Water, µg/L	Solid, µg/kg
Azinphos methyl	86-50-0	1.0	33
Bolstar (Suprofos)	35400-43-2	1.0	33
Chlorpyrifos	2921-88-2	1.0	33
Coumaphos	56-72-4	1..0	33
Demeton, O and S	8065-48-3	1.0	33
Diazinon	333-41-5	1.0	33
Dichlorvos	62-73-7	1.0	33
Disulfoton	298-04-4	1.0	33
Ethoprop	13194-48-4	1.0	33
Fensulfothion	115-90-2	1.0	33
Fenthion	55-38-9	1.0	33
Malathion	121-75-5	1.0	33
Merphos	150-50-5	1.0	33
Methyl Parathion	298-00-0	1.0	33
Mevinphos	7786-34-7	1.0	33
Naled	300-76-5	1.0	33
Phorate	298-02-2	1.0	33
Ronnel	299-84-3	1.0	33
Stirophos	22248-79-9	1.0	33
Tokuthion	34643-46-4	1.0	33
Trichloronate	327-98-0	1.0	33
O,O,O-Trientyl phosphorothioate	126-68-1	1.0	33
Thionazin	297-97-2	1.0	33
Sulfotepp	3689-24-5	1.0	33
Dimethoate	60-51-5	1.0	33
Parathion	56-38-2	1.0	33
Famphur	52-85-7	1.0	33

Table E2: Instrumental Conditions	
PARAMETER	Recommended conditions
Injection port temp	175°C
Detector temp	230°C
Initial temp	135°C
Temperature program	(A) 5°C/minute (B) 20°C/minute
Final Temp	(A) 245°C (B) 295°C
Final Hold Time	(A) 0 minutes (B) 7 minutes
Column 1	RTX-OPP, 30 meter, 0.32 mm, 0.5 µm film
Column 2	RTX-1, 30 meter, 0.32 mm, 0.5 µm film
Injection	1-2µL
Carrier gas	Helium / Hydrogen
Make up gas	Nitrogen

Table E3 Initial Calibration Concentrations (ng/uL)

COMPOUND	LEVEL1	LEVEL2	LEVEL3	LEVEL4	LEVEL5	LEVEL6	LEVEL7
o,o,o-Triethylp-hosphate	0.2	0.5	1	2	5	10	20
Dichlorvos	0.2	0.5	1	2	5	10	20
Mevinphos	0.2	0.5	1	2	5	10	20
Thionazin	0.2	0.5	1	2	5	10	20
Ethoprop	0.2	0.5	1	2	5	10	20
Naled	0.2	0.5	1	2	5	10	20
Sulfotepp	0.2	0.5	1	2	5	10	20
Phorate	0.2	0.5	1	2	5	10	20
Demeton	0.2	0.5	1	2	5	10	20
Dimethoate	0.2	0.5	1	2	5	10	20
Diazinon	0.2	0.5	1	2	5	10	20
Disulfoton	0.2	0.5	1	2	5	10	20
Methyl Parathion	0.2	0.5	1	2	5	10	20
Ronnel	0.2	0.5	1	2	5	10	20
Fenthion	0.2	0.5	1	2	5	10	20
Chlorpyrofos	0.2	0.5	1	2	5	10	20
Parathion	0.2	0.5	1	2	5	10	20
Malathion	0.2	0.5	1	2	5	10	20
Trichloronate	0.2	0.5	1	2	5	10	20
Merphos	0.2	0.5	1	2	5	10	20
Stirophos	0.2	0.5	1	2	5	10	20
Tokuthion	0.2	0.5	1	2	5	10	20
Fensulfothion	0.2	0.5	1	2	5	10	20
Bolstar	0.2	0.5	1	2	5	10	20
Famphur	0.2	0.5	1	2	5	10	20
Azinphos methyl	0.2	0.5	1	2	5	10	20
Coumaphos	0.2	0.5	1	2	5	10	20

Table E4: LCS/Matrix Spike and Surrogate Spike Compounds – 20 ug/mL

Compound	**Compound**
Thinazin	Sulfotepp
Phorate	Disulfoton
Methyl Parathion	Parathion
Famphur	O,O,O-Triethylphosphate
Dimethoate	Triphenyl Phosphate - Surrogate

1. Scope and Application

1.1. This method is applicable to the determination of the concentration and **tentative** identification of petroleum hydrocarbon mixes in waters, wastewaters, soils, and sludges.

1.2. This SOP is based on SW-846 Method 8015B, Modified, Revision 3, December 1996.

1.3. The associated LIMS method codes are HS (8015 MOD) and KI (8015B).

2. Summary of Method

2.1. This method provides gas chromatographic conditions for detection and identification of total petroleum hydrocarbons. Prior to the use of this method, appropriate sample preparation techniques are used.

2.2. An aliquot of the prepared sample is injected into a gas chromatograph (GC) and compounds in the effluent are detected by a flame ionization detector (FID).

2.3. The carbon range for Ohio VAP and BUSTR projects is C10-C20 and C20-C34.

3. Definitions

3.1. Refer to the glossary in the STL North Canton Laboratory Quality Manual (LQM), current version.

4. INTERFERENCES

4.1. Refer to the method 8000B section of this SOP for general information regarding chromatographic interferences.

5. SAFETY

5.1. Refer to Section 5 of the Method 8000B SOP for general safety requirements.

6. EQUIPMENT AND SUPPLIES

6.1. Refer to Section 6 of the 8000B section of this SOP.

6.2. Microsyringes, various sizes, for standards preparation, sample injection, and extract dilution.

7. REAGENTS AND STANDARDS

7.1. Refer to Section 7 of the 8000B section of this SOP.

7.2. The petroleum hydrocarbons are purchased from a chemical supplier when available. When no chemical supplier is available, the fuels are purchased from public sources.

7.3. The OVAP and BUSTR standard is a commercially prepared standard containing alkanes from C10-C34.

8. SAMPLE PREPARATION, PRESERVATION AND STORAGE

8.1. Refer to Section 8 of the 8000B section of this SOP.

9. QUALITY CONTROL

9.1. Refer to Section 9 of the 8000B section of this SOP for quality control requirements, including the initial demonstration of capability, definition of a batch, surrogate limits, method blanks, laboratory control samples (LCS), and matrix spikes (MS).

9.2. MS/MSD recoveries are calculated from a Diesel calibration.

9.3. Surrogates

9.3.1. Because of the nature of the TPH analysis, whereas certain petroleum mixtures can override the C9 surrogate, the C9 surrogate recoveries are advisory. Re-extraction due to surrogate recoveries is determined by analyst judgement.

NOTE: Ohio VAP rules require reanalysis when surrogate recoveries are outside of control limits.

10. CALIBRATION AND STANDARDIZATION

10.1. Recommended Instrument Conditions

10.1.1. Hydrogen carrier gas - flow rate 5 - 6 mL/min

10.1.2. Detector gas mixture - air hydrogen mixture in a 10:1 ratio, air 80 - 120 mL/min, hydrogen 8 -12 mL/min

10.1.3. Temperature Program - refer to Appendix

10.1.4. Injection volume - 1 µL

10.2. Initial Calibration

10.2.1. Analyze a five point Diesel calibration standard referring to the recommended instrument conditions. The calibration concentrations are 100, 200, 500, 1000, and 2000 ng/uL. A 5000ng/uL standard may be analyzed if needed. The retention time window of C10-C32 shall be used for the Diesel calibration.

10.2.2. For Ohio VAP and BUSTR calibrations, analyze a five point calibration for the carbon range C10-C20. The concentrations are 60, 120, 240, 600 and 1200 ug/mL. Analyze a five point of the carbon range C20-C34. The concentration ranges are 80, 160, 320, 800, and 1600 ug/mL.

10.3. Continuing Calibration

10.3.1. Refer to Section 10 of the 8000B section of this SOP for general calibration requirements.

11. PROCEDURE

11.1. Refer to the method 8000B section of this SOP for procedural requirements.

11.2. Extraction

The extraction procedure is described in SOP #CORP-OP-0001NC.

11.3. Cleanup

11.4. Analytical Sequence – Refer to Section 11 in the 8000B Section of this SOP.

11.5. Petroleum Hydrocarbon Identification and/or Fingerprinting

11.5.1. To identify the type of petroleum hydrocarbon, compare the chromatographic peak pattern to the patterns of known petroleum hydrocarbons analyzed under identical chromatographic conditions. Samples are quantified against diesel, but fingerprinting may be done when client requested.

11.5.2. Positive matching may not be possible, even using site-specific hydrocarbons. Degradation of the pattern can occur during environmental exposure of the fuel. See Table 2 for possible fingerprints.

11.6. Sample Quantification

11.6.1. Samples are quantified against the initial calibration of diesel or DRO on a single column.

11.6.2. The total height or area of the hydrocarbon is determined in the same manner used for the hydrocarbon standard.

11.6.3. If the amount of sample injected into the GC exceeds the working range of the calibration curve, an appropriate dilution is performed before reanalysis.

12. DATA ANALYSIS AND CALCULATIONS

12.1. Refer to the 8000B section of this SOP for identification and quantitation of single component analytes.

12.2. Surrogate recovery results are calculated and reported for Nonane (C-9) unless it is determined that sample interference has adversely affected the quantitation of one of the surrogates. The surrogate must be within QC criteria. Corrective action is only necessary if Nonane (C-9) is outside of acceptance limits.

13. METHOD PERFORMANCE

13.1. Performance limits for the four replicate initial demonstration of capability are required as referenced under Section 13.1 of the main body of this SOP.

14. POLLUTION PREVENTION

Refer to section 14 of the 8000B section of this SOP.

15. WASTE MANAGEMENT

15.1. Waste generated in this procedure will be segregated and disposed according to the facility hazardous waste procedures. The Environmental Health and Safety Director should be contacted if additional information is required.

16. REFERENCES

16.1. SW846, Method 8015B, Nonhalogenated Organics Using GC/FID, Test Methods for Evaluating Solid Waste, Third Edition, USEPA

16.2. Related SOP

16.2.1. CORP-OP-0001NC, Extraction and Cleanup of Organic Compounds from Waters and Soils, Based on SW846 3500 Series, 3600 Series, 8150, 8151, and 600 Series Methods

Table F1: Suggested GC Temperature Program for TPH analysis

Initial Temperature	40°C
Initial Hold Time	4 minutes
Temperature Program	10°C/minute
Final Temperature	280°C
Final Hold Time	10 minutes

Table F2: Reporting Limits for TPH Analysis

Analyte	Reporting Limits		
	Water (µg/L)	Solids (mg/kg)	Waste Dilution (mg/kg)
TPH (as Diesel) or DRO	100	3.3	200
C10-C20 (OVAP & BUSTR)	60	2.0	
C20-C34 (OVAP & BUSTR)	80	2.3	
Fingerprint Compounds[1]			
Mineral Spirits	Kerosene	Motor Oil	
Hydraulic Oil	Jet Fuel	Stoddard Solvent	
DRO Spiking Solution			
Decane	Dodecane	Tetradecane	
Hexadecane	Octobecane	Eicosane	
Docosane	Tetracosane	Hexacosane	
Octacosane			

[1] This list represents most of the common petroleum hydrocarbons. The list may be expanded to include other petroleum hydrocarbons.

1. Scope and Application

1.1. This method is applicable to the determination of the concentration of various Non-halogenated Organic Compounds in waters, wastes, sludges, and solids. It is based on SW-846 Method 8015B.

1.2. The applicable LIMs method codes are J7 (GC/FID 8015) and QU (Semivolatile Organics, 8015B). The preparation code is 88.

2. Summary of Method

2.1. This method provides gas chromatographic conditions for the detection of various nonhalogenated organic compounds. Samples are introduced to the GC by direct injection. Detection is achieved by a flame ionization detector (FID).

3. Definitions

3.1. Refer to the glossary in the STL North Canton Laboratory Quality Manual (LQM).

4. INTERFERENCES

4.1. Refer to the method 8000B section of this SOP for general information regarding chromatographic interferences.

5. SAFETY

5.1. Refer to section 5 of the Method 8000B SOP for general safety requirements.

6. EQUIPMENT AND SUPPLIES

6.1. Refer to Section 6 of the 8000B section of this SOP.

6.2. Recommended Columns:

6.2.1. RTX Stabilwax, fused silica, 60 m x 0.53, 0.5 µm film thickness, or equivalent column.

6.2.2. Stabilwax-DA, fused silica, 60 m x 0.32, 0.5 µm film thickness, or equivalent column.

6.3. Detectors: Flame ionization (FID)

6.4. Microsyringes, various sizes, for standards preparation, sample injection, and extract dilution.

7. REAGENTS AND STANDARDS

7.1. Refer to Section 7 of the 8000B section of this SOP.

7.1.1. Reagent water

7.2. Standards

7.2.1. Refer to Table G2.

8. SAMPLE PREPARATION, PRESERVATION AND STORAGE

8.1. Refer to section 8 of the 8000B section of this SOP.

9. QUALITY CONTROL

9.1. Refer to Section 9 of the 8000B section of this SOP for quality control requirements, including the initial demonstration of capability, definition of a batch, surrogate limits, method blanks, laboratory control samples (LCS), and matrix spikes (MS).

10. CALIBRATION AND STANDARDIZATION

10.1. Recommended Instrument Conditions

10.1.1. The following conditions are recommended. The following table lists specific information for various compounds.

10.1.2. RTX- Stabilwax and Stabilwax-DA Columns:

Carrier Gas:	Hydrogen
Initial Temp:	45 ^{o}C
Initial Hold:	3 mins
Ramp Rate A:	5 ^{o}C/min
Ramp Rate B:	30 ^{o}C/min
Final Hold A:	0 min
Final Hold B:	3 mins
Analysis Time:	17.83 mins
Injector Temp:	275 ^{o}C
FID Temp:	300 ^{o}C
Injection Vol:	1 µL

10.2. Initial Calibration

10.2.1. For each non-halogenated organic compound and surrogate standard, analyze five or more calibration standards referring to the recommended GC conditions in Section 10.1. One of the standards analyzed should be at or near the concentration which corresponds to the calibration range.

10.2.2. Refer to Section 10 of the 8000B section of this SOP for general calibration requirements.

11. PROCEDURE

11.1. Refer to the method 8000B section of this SOP for procedural requirements.

11.2. Sample Preparation Summary

11.2.1. Samples received fall into three general categories: waters, soils, or wastes.

11.3. Sample Preparation Procedure

11.3.1. Waters

11.3.1.1. Add surrogate solution to the sample to achieve a concentration of 100 mg/L.

11.3.2. Sediments/soils and waste

11.3.2.1. Mix the contents of the sample container with a narrow metal or wood spatula. Weigh 5 g (wet weight) into a tarred culture tube. Use a top-loading balance. Record the weight to 0.01 gram.

11.3.2.2. Quickly add 5 mL of reagent water. Add surrogate standard. Cap the vial and vortex to mix for two minutes.

11.3.2.3. If extract is cloudy or has suspended sediment particles, refrigerate and allow sample to sit for a maximum of 24 hours. Filter sample if necessary.

11.4. Sample Analysis

11.4.1. Preliminary Evaluation

11.4.1.1. The sample or sample extract is introduced to the GC column by direct inject techniques. The concentration of the sample components is then calculated from the resulting chromatograms.

11.4.2. Analytical Sequence – Refer to Section 11 in the 8000B Section of this SOP.

11.4.3. Inject 1 µL of the sample extract or diluted sample into the GC using the same operating conditions and techniques as those used in the calibration of the instrument.

11.5. Analytical Documentation

11.5.1. Record all analytical information in the analytical logbook/logsheet, including the analytical data from standards, blanks, LCSs, MS/MSDs, and any corrective actions or modifications to the method.

11.5.2. All standards are logged into a department standard logbook. All standards are assigned a unique number for identification. Logbooks are reviewed by the supervisor or designee.

11.5.3. Documentation such as all associated instrument printouts (final runs, screens, reruns, QC samples, etc.) and daily calibration data corresponding to all final runs is available for each data file.

12. DATA ANALYSIS AND CALCULATIONS

12.1. Refer to the 8000B section of this SOP for identification and quantitation of single component analytes.

12.2. Surrogate recovery results are calculated and reported unless it is determined that sample interference has adversely affected the quantitation of the surrogate. The surrogate must be within QC criteria. Corrective action is only necessary if the surrogate is outside of acceptance limits.

13. METHOD PERFORMANCE

13.1. Performance limits for the four replicate initial demonstration of capability are required as referenced under Section 13.1 of the main body of this SOP.

14. POLLUTION PREVENTION

Refer to section 14 of the 8000B section of this SOP.

15. WASTE MANAGEMENT

15.1. Waste generated in this procedure will be segregated and disposed according to the facility hazardous waste procedures. The Environmental Health and Safety Director should be contacted if additional information is required.

16. REFERENCES

16.1. SW846, Method 8015B, Nonhalogenated Organics Using GC/FID, Test Methods for Evaluating Solid Waste, Third Edition, USEPA

17. Miscellaneous (Tables, Appendices, Etc...)

Table G1 Non-halogenated Organic Compounds, Reporting Limits[1]

Compound	CAS Number	Reporting Limits	
		Water, mg/L	Solid, mg/kg
2-Methoxyethanol	109-86-4	1.0	1.0
Methanol	67-56-1	1.0	0.5
Isopropyl alcohol	67-63-0	1.0	0.5
n-Propyl alcohol	71-23-8	1.0	0.5
Ethanol	64-17-5	1.0	0.5
n-Butanol	71-36-3	1.0	0.5
1,4-Dioxane	123-91-1	1.0	0.5
Ethylene oxide	75-21-8	1.0	0.5
iso-Butanol	78-83-1	1.0	0.5

[1] If samples require dilution or smaller volumes than specified in this method, the RL will be elevated.

Table G2 Non-halogenated Organic Compounds Working Standards

COMPOUND	LEVEL1	LEVEL2	LEVEL3	LEVEL4	LEVEL5	LEVEL 6
2-Methoxyethanol	1.0	2.0	5.0	10.0	20.0	50.0
Methanol	1.0	2.0	5.0	10.0	20.0	50.0
Isopropyl alcohol	1.0	2.0	5.0	10.0	20.0	50.0
n-Propyl alcohol	1.0	2.0	5.0	10.0	20.0	50.0
Ethanol	1.0	2.0	5.0	10.0	20.0	50.0
n-Butanol	1.0	2.0	5.0	10.0	20.0	50.0
1,4-Dioxane	1.0	2.0	5.0	10.0	20.0	50.0
Ethylene oxide	1.0	2.0	5.0	10.0	20.0	50.0
iso-Butanol	1.0	2.0	5.0	10.0	20.0	50.0

1. Scope and Application

1.1. This method is applicable to the determination of the concentration of Sulfolane and N-Methyl-2-pyrrolidone in water and solid samples. It is based on SW846 Method 8015B. The working linear range is 50 to 1000 µg/L. Table I1 lists the reporting limits associated with this method.

1.2. The applicable LIMS method code is KU.

2. Summary of Method

2.1. This method provides gas chromatographic conditions for the detection of mg/L levels of Phillips 66 compounds in water. Prior to use of this method, appropriate sample extraction techniques must be used.

3. Definitions

3.1. Refer to the glossary in the STL North Canton Laboratory Quality Manual (LQM), current version.

4. INTERFERENCES

4.1. Refer to the method 8000B section of this SOP for general information regarding chromatographic interferences.

5. SAFETY

5.1. Refer to section 5 of the Method 8000B SOP for general safety requirements.

5.2. The health and safety hazards of many of the chemicals used in this procedure have not been fully defined. Additional health and safety information can be obtained from the Material Safety Data Sheets (MSDS) maintained in the laboratory. The following specific hazards are known:

5.2.1. Chemicals that have been classified as **carcinogens,** or **potential carcinogens,** under OSHA include: **Methylene Chloride.**

6. EQUIPMENT AND SUPPLIES

6.1. Refer to Section 6 of the 8000B section of this SOP.

6.2. Gas Chromatograph

6.2.1. Gas Chromatograph: Modified to accept capillary columns

6.2.2. Data System: Capable of peak integration

6.2.3. Gas Chromatographic Column: 30 m x 0.32 mm ID RTX-5 fused silica capillary column

6.2.4. Autosampler: Capable of reproducible injections

6.2.5. Carrier Gas: Hydrogen

6.2.6. Detector: Flame ionization (FID)

6.3. Volumetric Flasks: 10, 50, and 100 mL

6.4. Microsyringe: 10 µL

6.5. Pipettes: Disposable µL, Pasteur

6.6. Autosampler Vials: 1 mL with 11 mm crimp cap, Teflon®/silicone septum liner.

7. REAGENTS AND STANDARDS

7.1. Refer to Section 7 of the 8000B section of this SOP.

7.2. Reagents

7.2.1. Methylene Chloride: Pesticide grade or equivalent

7.3. Standards

7.3.1. Refer to Section 7 of the 8000B section of this SOP.

8. SAMPLE PREPARATION, PRESERVATION AND STORAGE

8.1. Refer to Section 8 of the 8000B section of this SOP.

9. QUALITY CONTROL

9.1. Refer to Section 9 of the 8000B section of this SOP for quality control requirements, including the initial demonstration of capability, definition of a batch, surrogate limits, method blanks, laboratory control samples (LCS), and matrix spikes (MS).

9.2. Surrogates are not used for this analysis.

10. CALIBRATION AND STANDARDIZATION

10.1. Initial Calibration

10.1.1. Refer to Section 10 of the 8000B section of this SOP for general calibration requirements.

11. PROCEDURE

11.1. Refer to the method 8000B section of this SOP for procedural requirements.

11.2. Sample Analysis

11.2.1. Summary

11.2.1.1. The sample extract is injected onto the GC column. The compounds are then identified and quantitated.

11.2.2. Recommended Instrument Conditions

11.2.2.1. GC Conditions

Initial Temperature:	45°C
Initial Hold Time:	4 minutes
Temperature Program:	15°C/minute
Final Temperature:	300°C, hold 2 minutes
Final Time:	23 minutes
Carrier Gas:	Hydrogen
Injection Volume:	1 µL

11.2.3. Sample Analysis Procedure

11.2.3.1. Preliminary Evaluation

The sample extracts may be screened to determine the level of analyte present. If the level of analyte exceeds the working range of the calibration curve, an appropriate dilution is performed to bring the level within the calibration range.

11.2.4. Inject 1 µL of the sample extract or diluted sample into the GC using the same conditions as those used in calibration.

11.2.5. Identification

11.2.5.1. Analytes of interest are identified by comparing retention times with known standards.

11.2.5.2. A single column is used for identification.

11.2.6. Sample Quantification

11.2.6.1. Refer to Section 11 in the 8000B Section of this SOP

11.3. Analytical Documentation

11.3.1. Record all analytical information in the analytical logbook/logsheet, including the analytical data from standards, blanks, LCSs, MS/MSDs, and any corrective actions or modifications to the method.

11.3.2. All standards are logged into a department standard logbook. All standards are assigned a unique number for identification. Logbooks are reviewed by the supervisor or designee.

11.3.3. Documentation such as all associated instrument printouts (final runs, screens, reruns, QC samples, etc.) and daily calibration data corresponding to all final runs is available for each data file.

12. DATA ANALYSIS AND CALCULATIONS

12.1. Refer to the 8000B section of this SOP for identification and quantitation of single component analytes.

13. METHOD PERFORMANCE

13.1. Performance limits for the four replicate initial demonstration of capability are required as referenced under Section 13.1 of the main body of this SOP.

14. POLLUTION PREVENTION

14.1. Refer to section 14 of the 8000B section of this SOP.

15. WASTE MANAGEMENT

15.1. Waste generated in this procedure will be segregated and disposed according to the facility hazardous waste procedures. The Environmental Health and Safety Director should be contacted if additional information is required.

16. REFERENCES

16.1. SW846, Method 8015B, Nonhalogenated Organics Using GC/FID, Test Methods for Evaluating Solid Waste, Third Edition, USEPA

17. Miscellaneous (Tables, Appendices, Etc...)

17.1. Reporting limits

17.1.1. The lower reporting limits are shown in Table H1

17.1.2. If samples require dilution or smaller volumes than specified in this method, the RL will be elevated.

TABLE H1
PHILLIPS 66 REPORTING LIMITS

Compound	Reporting Limits, mg/L
Tetramethylene sulfone (Sulfolane)	50
N-Methyl-2-pyrrolidone	50

STL NORTH CANTON STANDARD OPERATING PROCEDURE

TITLE: ACID DIGESTION OF SOILS, SW846 METHOD 3050B

(SUPERSEDES: REVISION 2.4, DATED 02/19/03)

Prepared by:	Larry R. Williams	12-9-04 Date
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Reviewed by:	Quality Assurance Manager	12/15/04 Date
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Reviewed by:	Laboratory Director	12/13/04 Date
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1. SCOPE AND APPLICATION

1.1. This procedure describes the preparation of soil samples for the analysis of certain metals by Graphite Furnace Atomic Absorption (GFAA), Flame Atomic Absorption (FLAA), Inductively Coupled Plasma Atomic Emission Spectroscopy (ICP), and Inductively Coupled Plasma-Mass Spectrometry (ICP/MS) as specified in SW846 Method 3050B.

1.2. Samples prepared by the protocols detailed in this SOP may be analyzed by ICP, ICP/MS, FLAA or GFAA for the elements listed in Table I (Appendix A). Other elements and matrices may be analyzed following digestion by these protocols provided that the method performance criteria specified in Section 13.0 of this SOP are met.

1.3. This method is not a total digestion, but will dissolve almost all metals that could become "environmentally available". By design, metals bound in silicate structures are not dissolved by this procedure, as they are not usually mobile in the environment. This SOP can be applied to metals in solids, sludges, wastes and sediments.

1.4. This document accurately reflects current laboratory standard operating procedures (SOP) as of the date above. All facility SOPs are maintained and updated as necessary.

2. SUMMARY OF METHOD

A representative 1 gram (wet weight) portion of sample is digested in nitric acid and hydrogen peroxide. The digestate is refluxed with hydrochloric acid for ICP or FLAA analysis. The digestates are then filtered and diluted to 100 mL/100 g.

3. DEFINITIONS

3.1. Refer to the glossary in the Laboratory Quality Manual (LQM), latest version.

3.2. Total Metals: The concentration determined on an unfiltered sample following digestion. Note that this method is designed to determine the total *environmentally available* metals.

4. INTERFERENCES

4.1. There are numerous routes by which samples may become contaminated. Potential sources of trace metals contamination include: metallic or metal-containing labware (e.g., talc gloves which contain high levels of zinc), containers, impure reagents, dirty glassware, improper sample transfers, dirty work areas, atmospheric inputs such as dirt and dust, etc. Be aware of potential sources of contamination and take appropriate measures to minimize or avoid them.

4.2. The entire work area, including the bench top and fume hood, should be thoroughly cleaned on a routine schedule in order to minimize the potential for environmental contamination.

4.3. Boron and silica from the glassware will grow into the sample solution during and following sample processing. For critical low level determinations of boron and silica, only quartz and/or plastic labware should be used.

4.4. Physical interference effects may contribute to inaccuracies in the determinations of trace elements. Oils, solvents and other matrices may not be digested using these methods if they are not soluble with acids. If physical interferences are present, they should be documented.

4.5. Visual interferences or anomalies (such as foaming, emulsions, precipitates, etc.) must be documented.

4.6. Allowing samples to boil or go dry during digestion may result in the loss of volatile metals. If this occurs the sample must be reprepared. Antimony is easily lost by volatilization from hydrochloric media.

4.7. Specific analytical interferences are discussed in each of the determinative methods.

5. SAFETY

5.1. Employees must abide by the policies and procedures in the Corporate Safety Manual, Radiation Safety Manual and this document.

5.2. Samples that contain high concentrations of carbonates or organic material or samples that are at elevated pH can react violently when acids are added.

5.3. The following is a list of the materials used in this method, which have a serious or significant hazard rating. **NOTE: This list does not include all materials used in the method. The table contains a summary of the primary hazards listed in the MSDS for each of the materials listed in the table.** A complete list of materials used in the method can be found in the reagents and materials section. Employees must review the information in the MSDS for each material before using it for the first time or when there are major changes to the MSDS.

Material (1)	Hazards	Exposure Limit (2)	Signs and symptoms of exposure

Hydrochloric Acid	Corrosive Poison	5 ppm-Ceiling	Inhalation of vapors can cause coughing, choking, inflammation of the nose, throat, and upper respiratory tract, and in severe cases, pulmonary edema, circulatory failure, and death. Can cause redness, pain, and severe skin burns. Vapors are irritating and may cause damage to the eyes. Contact may cause severe burns and permanent eye damage.
Hydrogen Peroxide	Oxidizer Corrosive	1 ppm-TWA	Vapors are corrosive and irritating to the respiratory tract. Vapors are very corrosive and irritating to the eyes and skin.
Nitric Acid	Corrosive Oxidizer Poison	2 ppm-TWA 4 ppm-STEL	Nitric acid is extremely hazardous; it is corrosive, reactive, an oxidizer, and a poison. Inhalation of vapors can cause breathing difficulties and lead to pneumonia and pulmonary edema, which may be fatal. Other symptoms may include coughing, choking, and irritation of the nose, throat, and respiratory tract. Can cause redness, pain, and severe skin burns. Concentrated solutions cause deep ulcers and stain skin a yellow or yellow-brown color. Vapors are irritating and may cause damage to the eyes. Contact may cause severe burns and permanent eye damage.
1 – Always add acid to water to prevent violent reactions.			
2 – Exposure limit refers to the OSHA regulatory exposure limit.			

5.4. Eye protection that protects against splash, laboratory coat, and appropriate gloves must be worn while samples, standards, solvents, and reagents are being handled. Cut resistant gloves must be worn doing any other task that presents a strong possibility of getting cut. Disposable gloves that have been contaminated will be removed and discarded; other gloves will be cleaned immediately

5.5. The acidification of samples containing reactive materials may result in the release of toxic gases, such as cyanides or sulfides. Acidification of samples should be done in a fume hood. The analyst should also be aware of the potential for a vigorous reaction.

5.6. Exposure to chemicals must be maintained **as low as reasonably achievable.** Therefore, unless they are known to be non-hazardous, all samples should be opened, transferred and prepared in a fume hood, or under other means of mechanical ventilation. All samples with pink stickers that read "Caution/Use Hood!" **must** be opened in the hood. Contact the EH&S Coordinator if this is not possible. Solvent and waste containers will be kept closed unless transfers are being made.

5.7. The preparation of standards and reagents will be conducted in a fume hood with the sash closed as far as the operation will permit or under other means of mechanical ventilation.

5.8. All work must be stopped in the event of a known or potential compromise to the health and safety of a STL North Canton associate. The situation must be reported **immediately** to the EH&S Coordinator and the Laboratory Supervisor.

5.9. Always carry bulk concentrated acid bottles in appropriate impact proof containers.

5.10. Acid/peroxide spills must be neutralized immediately, flushed with water and cleaned up using appropriate spill kits.

5.11. Discard chipped or broken beakers to prevent injury. Chipped glassware may be fire polished as an alternative to disposal.

6. EQUIPMENT AND SUPPLIES

6.1. Hot plate, digestion block, steam bath or other heating source capable of maintaining a temperature of 90-99°C.

6.2. Calibrated thermometer that covers a temperature range of 0-200°C.

6.3. Griffin beakers of assorted sizes or equivalent.

6.4. Vapor recovery device (Watch glasses, ribbed or other device).

6.5. Whatman No. 41 filter paper or equivalent.

6.6. Funnels or equivalent filtration apparatus.

6.7. Centrifugation equipment (if desired method of removing particulates is centrifugation).

6.8. Graduated cylinder or equivalent capable of measuring 100 mL within 3% accuracy.

6.9. Analytical balance capable of accurately weighing to the nearest 0.01 grams.

6.10. Repippetors or suitable reagent dispensers.

6.11. Calibrated automatic pipettes with corresponding pipette tips or Class A glass volumetric pipettes.

6.12. Class A volumetric flasks.

6.13. pH indicator strips (pH range 0 - 6).

6.14. Plastic bottles.

7. REAGENTS AND STANDARDS

7.1. Reagent water must be produced by a Millipore DI system or equivalent. Reagent water must be free of the analytes of interest as demonstrated through the analysis of method blanks as defined in the determinative SOPs.

7.2. Laboratory Control Sample (LCS) and matrix spike (MS) solutions are purchased as custom STL North Canton solutions. All standards must be stored in FEP fluorocarbon or previously unused polyethylene or polypropylene bottles. Stock standard solutions must be replaced prior to the expiration date provided by the manufacturer. If no expiration date is provided, the stock solutions may be used for up to one year and must be replaced sooner if verification from an independent source indicates a problem.

7.3. Working ICP LCS/MS spike solution: Prepare the ICP LCS/MS working spike solutions from custom stock standards to the final concentration listed in Table II. The working spike must be prepared in a matrix of 5% HNO_3. This acid (5 mL of concentrated HNO_3 per 100 mL) must be added to the volumetric flask before the addition of the stock standard aliquot. The working ICP LCS solution must be made fresh every three months.

7.4. Working GFAA LCS/MS spike solution: Prepare the GFAA working LCS/MS spike solutions by diluting the custom stock solution (7.2) 200x. The working spike solution must be prepared in a matrix of 5% HNO_3. This acid (5 mL of concentrated HNO_3 per 100 mL) must be added to the volumetric flask before the addition of the stock standard aliquot. The working GFAA LCS/MS solution must be made fresh every three months.

7.5. The LCS and MS samples must contain all the elements designated for analysis in each batch of samples. If a non-routine element is required that is not contained in the custom STL North Canton solution, the individual facility must purchase a solution from the designated

vendor that will cover the additional analyte(s) of interest and provide for a final spike concentration that is appropriate to the determinative method.

7.6. Aqueous laboratory control samples (LCSW) and matrix spike samples are prepared as described in Sections 9.5 and 9.6. Refer to Tables II through IV (Appendix A) for details regarding the stock, working standard and final digestate spike concentrations for ICP and GFAA LCS and matrix spike preparations.

7.7. Nitric acid (HNO_3), concentrated, trace metal grade or better.

7.8. Nitric acid, 1:1 - dilute concentrated HNO_3 with an equal volume of reagent water.

Note: When preparing diluted acids always add acid to water. If the water is added to the acid a violent reaction may occur.

7.9. Hydrochloric acid (HCl), concentrated, trace metal grade or better.

7.10. Hydrochloric acid, 1:1 - dilute concentrated HCl with an equal volume of reagent water.

Note: When preparing diluted acids always add acid to water. If the water is added to the acid a violent reaction may occur.

7.11. 30% Hydrogen peroxide (H_2O_2), reagent grade.

8. SAMPLE COLLECTION, PRESERVATION AND STORAGE

8.1. Sample holding time for metals included under the scope of this SOP is 180 days from the date of collection to the date of analysis.

8.2. Soil samples do not require preservation but must be stored at 4 °C ± 2 °C until the time of analysis.

9. QUALITY CONTROL

Table V (Appendix A) provides a summary of quality control requirements including type, frequency, acceptance criteria and corrective action.

9.1. Initial Demonstration of Capability

Prior to analysis of any analyte using Method 3050B the following requirements must be met.

9.1.1. Method Detection Limit (MDL) - An MDL must be determined for each analyte/matrix prior to the analysis of any samples. The MDL is determined using seven replicates of reagent water, spiked with all the analytes of interest, that have been carried through the entire analytical procedure. MDLs must be redetermined on an annual basis in accordance with 40 CFR Part 136 Appendix B requirements or verified as detailed in STL North Canton QA Policy QA-005. The spike level must be between the calculated MDL and 10X the MDL to be valid. The result of the MDL determination must be below the STL North Canton reporting limit.

9.1.2. Initial Demonstration Study- this requires the analysis of four QC check samples. The QC check sample is a well characterized laboratory generated sample used to monitor method performance, which should contain all the analytes of interest. The results of the initial demonstration study must be acceptable before analysis of samples may begin. The results of the initial demonstration study may be used to extend a method for the analysis of other elements provided all acceptance criteria are met.

9.1.2.1. Four aliquots of the check sample (LCS) are prepared and analyzed using the procedures detailed in this SOP and the determinative SOPs.

9.1.2.2. Calculations and acceptance criteria for QC check samples are given in the determinative SOPs (CORP-MT-0001, CORP-MT-0003).

9.2. Preparation Batch - A group of up to 20 samples that are of the same matrix and are processed together using the same procedures and reagents. The preparation batch must contain a method blank, a LCS and a matrix spike/matrix spike duplicate. In some cases, at client request, it may be appropriate to process a matrix spike and sample duplicate in place of the MS/MSD. If clients specify specific samples for MS/MSD, the batch may contain multiple MS/MSD pairs.

9.3. Sample Count - Laboratory generated QC samples (method blanks, LCS, MS/MSD) are not counted towards the maximum 20 samples in a batch. Field QC samples are included in the batch count.

9.4. Method Blank (MB) - One method blank must be processed with each preparation batch. The method blank consists of reagent water containing all reagents specific to the method that is carried through the entire analytical procedure, including preparation and analysis. The method blank is used to identify any system and process interferences or contamination of the analytical system that may lead to the reporting of elevated analyte concentrations or false

positive data. Criteria for the acceptance of blanks are contained within the individual analytical method SOP's. If the method blank does not meet the criteria contained within the analytical method SOPs, the blank and all associated samples in the batch must be redigested.

9.5. Laboratory Control Sample (LCS) - One aqueous LCS must be processed with each preparation batch. The LCS must contain all analytes of interest and must be carried through the entire analytical procedure. The LCS is used to monitor the accuracy of the analytical process. On going monitoring of the LCS results provides evidence that the laboratory is performing the method within acceptable accuracy and precision guidelines. Criteria for the acceptance of LCS results are contained within the individual analytical method SOP's. Corrective action when LCS results fail to meet control limits will be repreparation and reanalysis of the batch. Tables II and III provide the details regarding the stock, working standards and final spike concentrations for ICP and GFAA. Refer to Section 7.3 or 7.4 for instructions on preparation of the aqueous LCS.

9.5.1. The LCS is prepared by spiking a 1mL or 1 g aliquot of reagent water with 2 mL of the working LCS/MS spike solution (7.3 or 7.4). The LCS is then processed as described in either Section 11.10.

9.6. Matrix Spike/Matrix Spike Duplicate (MS/MSD) - One MS/MSD pair must be processed for each preparation batch. A matrix spike (MS) is a field sample to which known concentrations of target analytes have been added. A matrix spike duplicate (MSD) is a second aliquot of the same sample (spiked identically as the MS) prepared and analyzed along with the sample and matrix spike. Some client specific data quality objectives (DQO's) may require the use of sample duplicates in place of or in addition to MS/MSD's. The MS/MSD results are used to determine the effect of a matrix on the precision and accuracy of the analytical process. Samples identified as field blanks cannot be used for MS/MSD analysis. If any analyte recovery or RPD falls outside the acceptance range, the recovery of that analyte must be in control for the LCS. If the recovery of the LCS is outside limits, corrective action must be taken. Corrective action will include repreparation and reanalysis of the batch. Corrective action when MS results fail to meet control limits does not include repreparation of samples unless the results indicate that a spiking error may have occurred. Tables II through IV provide the details regarding the stock, working standards and final matrix spike concentrations for ICP and GFAA. Refer to Sections 7.3 and 7.4 for instructions on preparation of the working matrix spike solutions.

9.6.1. The soil matrix spike sample is prepared by spiking a 1 g aliquot of a sample with 2mL of the working LCS/MS spike solution (7.3 or 7.4). The matrix spike sample is then processed as described in either Section 11.10.

9.7. Quality Assurance Summaries - Certain clients may require specific project or program QC which may supersede the SOP requirements. Quality Assurance Summaries (QAS) should be developed to address these requirements.

10. CALIBRATION AND STANDARDIZATION

10.1. Hotplate or block temperature must be verified daily for each unit used and must be recorded on either the metals preparation log or in a hotplate temperature logbook. The hotplate temperature should be verified by measuring the temperature of a beaker of reagent water placed on each hotplate. For block digestors, use a tube containing water.

11. PROCEDURE

11.1. One time procedural variations are allowed only if deemed necessary in the professional judgment of supervision to accommodate variation in sample matrix, radioactivity, chemistry, sample size, or other parameters. Any variation in procedure shall be completely documented using a Nonconformance Memo and is approved by a Technical Specialist and QA Manager. If contractually required, the client shall be notified. The Nonconformance Memo shall be filed in the project file.

11.2. Any unauthorized deviations from this procedure must also be documented as a nonconformance, with a cause and corrective action described.

11.3. The heating procedures are carried out in a properly functioning hood.

11.4. All samples are to be checked out of sample control with the chain of custody documentation filled out completely.

11.5. Proper sample identification is extremely important in any preparation procedure. Labeling of beakers and bottles must be done in a manner to ensure connection with the proper sample. The use of automatic label printing programs is recommended to reduce transcription errors (QuantIMS option).

11.6. Samples are typically logged in as either waters or soils. Wastes such as organic liquids or sludges and tissues (animal/vegetable) are usually logged in with solid test codes. When initiating prep, examine the sample to see if the sample matches the matrix designation. If the sample is logged in as aqueous but it appears more like a waste (biphasic, sludge like, organic liquid, lots of sediment etc.) contact the lab supervisor or project administrator for further instructions. In some cases it may be more appropriate to process these samples as solids.

11.7. If possible prepare all the samples of a project at the same time to minimize the QC required and streamline the flow of the project through the lab and reporting group.

11.8. In some cases, both AA and ICP digests are required on each sample. It is recommended that both aliquots be weighed out and processed at the same time.

11.9. Guidelines are provided in the appendices on procedures to minimize contamination of samples and standards.

11.10. Preparation of Soils, Sediments and Sludges for Analysis by GFAA, ICP, ICP/MS and FLAA.

11.10.1. Mix sample thoroughly by stirring with a clean plastic or wooden spoon or spatula. Some project plans may require, when possible, transfer of the entire sample from the original container to butcher paper or a clean beaker, mixing thoroughly, then returning the sample to its original container.

11.10.2. For each digestion procedure required (i.e., ICP or GFAA), weigh a 1.0 portion of solid and record the exact weight to the nearest 0.01 g. A 2 g sample size may also be used if needed to meet the reporting limits.

11.10.3. Measure additional aliquots of the designated samples for the MS and MSD analyses.

11.10.4. Spike each of the MS and MSD aliquots with 2 mL of the working LCS/MS spiking solution (7.3 or 7.4).

11.10.5. Prepare a beaker for the method blank.

11.10.6. Prepare a beaker for the LCS. Add 2 mL of the working LCS/MS spiking solution (7.3 or 7.4).

11.10.7. Add 10 mL of 1:1 HNO_3 and mix the sample.

11.10.8. Heat sample to $95^{o} \pm 4°$ C and reflux for 10 minutes without boiling, using a vapor recovery device.

Note: DO NOT ALLOW SAMPLE TO BOIL OR GO DRY during any part of the digestion. Doing so will result in the loss of analyte and the sample must be reprepared.

11.10.9. Allow sample to cool, if necessary.

11.10.10. Add 5 mL of concentrated HNO_3 and replace vapor recovery device.

11.10.11. Reflux at 95° ±4° C for 30 minutes. (Add reagent water as needed to ensure that the volume of solution is not reduced to less than 5 mL.)

11.10.12. If brown fumes are observed, repeat step 11.10.10 until no more fumes are evolved.

11.10.13. Allow the samples to cool, if necessary.

11.10.14. Add approximately 2 mL of reagent water and 1 mL of 30 % H_2O_2. Care must be taken to ensure that losses do not occur due to excessively vigorous effervescence.

11.10.15. Replace the vapor recovery device and heat sample until effervescence subsides.

11.10.16. Allow the sample to cool, if necessary.

11.10.17. Continue adding 30% H_2O_2 in 1 mL aliquots with warming until effervescence is minimal or sample appearance is unchanged.

Note: Do not add more than a total of 10 mL of 30 % H_2O_2.

11.10.18. Continue heating at 95° ±4° C for 75 minutes until the volume is reduced to approximately 5-10 mL. Alternatively the sample may be heated for 2 hours.

11.10.19. If the sample is being prepared for ICP or FLAA analyses add 10 mL of concentrated HCl and reflux for an additional 10 minutes without boiling. This step is omitted for analysis by ICP-MS and GFAA

Note: Antimony and silver have poor solubility in dilute nitric acid solution. Therefore it is strongly recommended that these elements are determined by the ICP procedure that includes HCl as the final digestion acid.

11.10.20. Allow the sample to cool.

11.10.21. Wash down beaker walls and vapor recovery device with reagent water.

11.10.22. Filter sample through Whatman 41 filter paper or equivalent into a graduated cylinder or equivalent or a pre-weighed bottle. Other measuring bottles (for example, Corning Snap Seals™) may be used if their accuracy is documented and is better than ± 2%. Rinse beaker and filter paper with reagent water to ensure complete sample transfer.

Note: In place of filtering, the samples, after dilution and mixing, may be centrifuged or allowed to settle by gravity overnight to remove insoluble material

11.10.23. Dilute sample to 100 mL or 100g with reagent water. The sample is now ready for analysis.

Note: This SOP allows for samples to be weighed instead of measured volumetrically. This assumes the density of the diluted sample is close to 1.0 g/mL (See Section 17.1.2).

12. DATA ANALYSIS AND CALCULATIONS

Not Applicable.

13. METHOD PERFORMANCE

13.1. Method performance is determined by the analysis of matrix spike and matrix spike duplicate samples as well as method blanks and laboratory control samples. In general, the matrix spike recovery should fall within +/- 20 % and the matrix spike duplicates should compare within 20% RPD. Method blanks must meet the criteria specified in the determinative SOPs. The laboratory control samples should recover within 20% of the true value until in house control limits are established. Acceptance criteria are given in the determinative SOPs.

13.2. The initial demonstration study as detailed in Section 9.1.2 must be acceptable before the analysis of field samples under this SOP may begin. The results of the initial demonstration study may be used to extend a method for the analysis of other elements provided all acceptance criteria are met.

13.3. Training Qualification:

The group/team leader has the responsibility to ensure that this procedure is performed by an associate who has been properly trained in its use and has the required experience.

14. POLLUTION PREVENTION

14.1. This method does not contain any specific modifications that serve to minimize or prevent pollution.

15. WASTE MANAGEMENT

15.1. All waste will be disposed of in accordance with Federal, State and Local regulations. Where reasonably feasible, technological changes have been implemented to minimize the potential for pollution of the environment. Employees will abide by this method and the policies in section 13 of the Corporate Safety Manual for "Waste Management and Pollution Prevention."

15.2. Waste Streams Produced by the Method

15.2.1. The following waste streams are produced when this method is carried out.

15.2.1.1. Acidic waste containing nitric acid generated by the extraction. This waste is disposed of in a designated container labeled "Acid Waste".

15.2.1.2. Contaminated disposable materials utilized for the analysis. This waste is disposed of in a designated container labeled "Solid Waste".

16. REFERENCES

16.1. References

16.1.1. Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, SW-846, 3rd Edition, Final Update III, December 1996. Method 3050B.

16.1.2. CORP-MT-0001, Inductively Coupled Plasma-Atomic Emission Spectroscopy, Spectrometric Method for Trace Element Analysis of Water and Wastes, Method 6010B and Method 200.7.

16.1.3. CORP-MT-0003, Graphite Furnace Atomic Absorption Spectroscopy, SW846 Method 7000A and MCAWW 200 Series Methods.

16.1.4. NC-MT-0002, Inductively Coupled Plasma-Mass Spectrometry, EPA Methods 6020 and 200.8.

16.1.5. Corporate Quality Management Plan (QMP), current version.

16.1.6. STL Laboratory Quality Manual (LQM), current version.

16.1.7. STL Corporate Safety Manual, M-E-0001 and STL North Canton Facility Addendum and Contingency Plan, current version.

16.2. Associated SOPs and Policies, latest version

16.2.1. QA-003, STL North Canton QC Program.

16.2.2. QA-004, Rounding and Significant Figures.

16.2.3. Glassware Washing, NC-QA-0014

16.2.4. Statistical Evaluation of Data and Development of Control Charts, NC-QA-0018

16.2.5. Method Detection Limits and Instrument Detection Limits, S-Q-003 and NC-QA-0021

16.2.6. Navy/Army SOP, NC-QA-0016

17. MISCELLANEOUS (TABLES, APPENDICES, ETC. . .)

17.1. Modifications/Interpretations from reference method.

17.1.1. Chapter 1 of SW-846 states that the method blank should not contain any analyte of interest at or above the MDL. This SOP states that the method blank must not contain any analyte of interest at or above the reporting limit. Common lab contaminants, as defined in the determinative SOPs, are allowed up to two times the reporting limit in the blank following consultation with the client.

17.1.2. This SOP allows for aqueous samples to be weighed instead of measured volumetrically. This assumes the density of the sample is close to 1.0 g/mL. Samples with large amounts of sediment or suspended solids, sludges, non-aqueous liquids must be processed volumetrically. Weighing samples directly into the digestion vessel minimizes the potential for cross contamination, offers improved accuracy over the use of graduated cylinders (comparable to volumetric flask accuracy), uses less glassware and is more efficient.

17.2. Modifications from previous SOP

17.2.1. ICP/MS has been added as an appropriate determinative technique.

17.2.2. The approved analyte list may be modified provided that additional elements meet the requirements in section 13.

17.2.3. Directions for digestion for set time periods rather than reduction to set volumes have been added.

17.2.4. The order of two steps in the digestion has been changed. (See section 11.10.20)

17.2.5. Definition of the method as determining total environmentally available metals has been added.

17.3. Facility Specific SOPs

Each facility shall attach a list of facility specific SOPs or approved attachments (if applicable) which are required to implement this SOP or which are used in conjunction with this SOP. If no facility specific SOPs or amendments are to be attached, a statement must be attached specifying that there are none. Refer to the Appendices for any facility specific information required supporting this SOP.

17.4. Documentation and Record Management

The preparation benchsheet should, at a minimum, include the following information:

- Preparation date, analyst initials, matrix, prep type (ICP or GFAA).
- Sample ID; initial weight/volume and final weight/volume.
- Standards Documentation (source, lot, prep date, volume added).
- Analyst initials.

Figure 1. Soil Sample Preparation (Section 11.10)

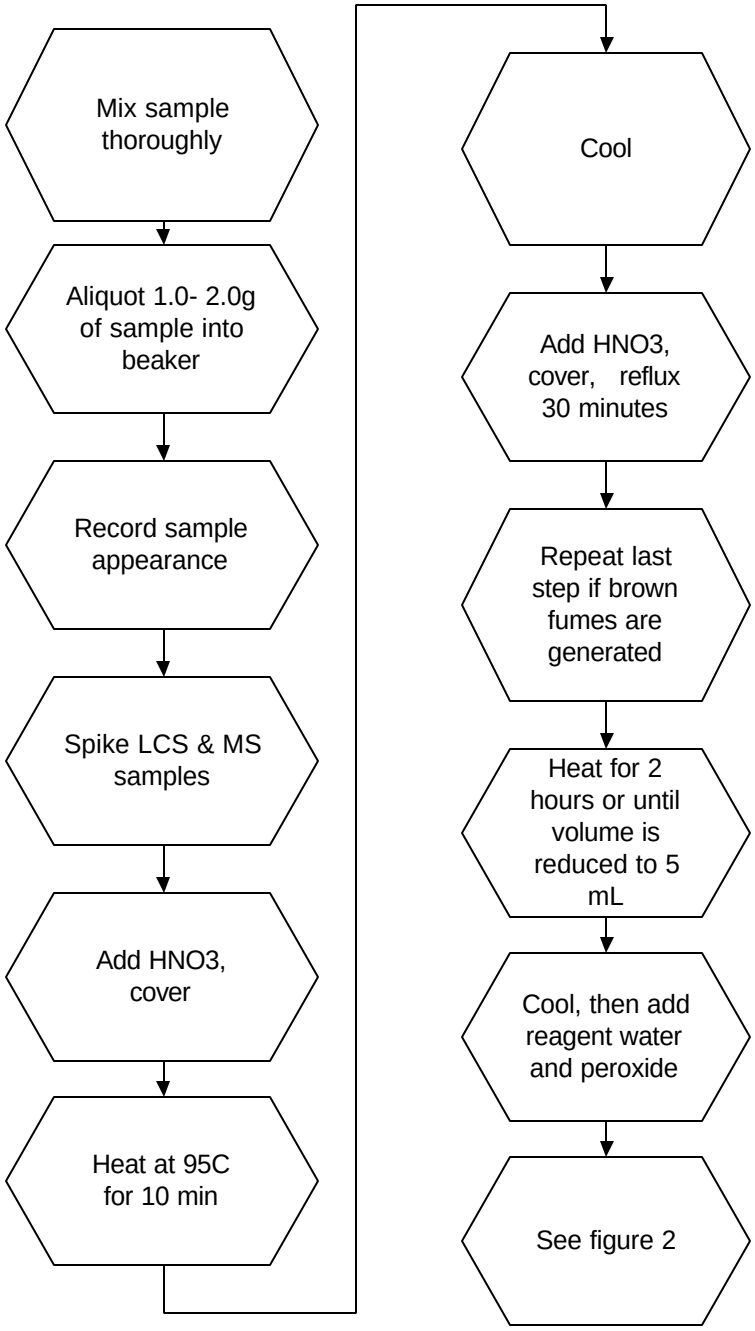
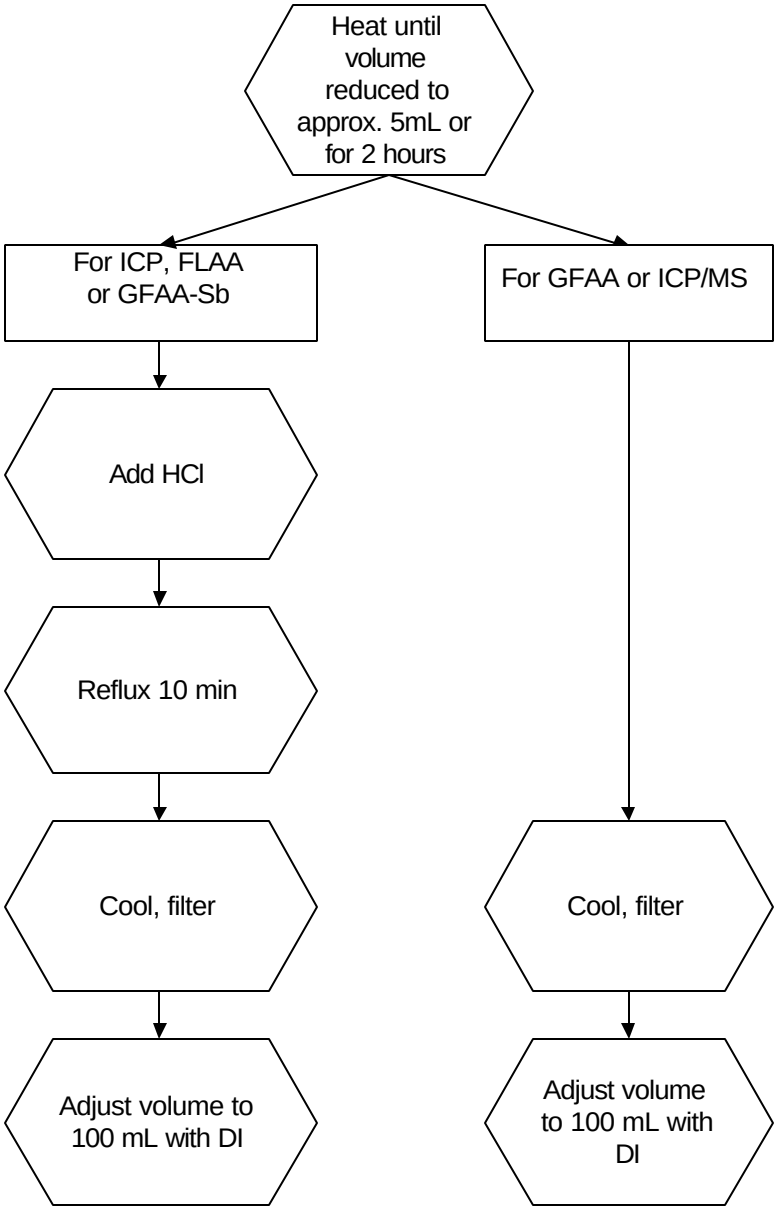


Figure 2. Soil Sample Preparation (continued)



APPENDIX A

TABLES

TABLE I. Method 3050A Approved Analyte List

ELEMENT	Symbol	CAS Number
Aluminum	Al	7429-90-5
Antimony	Sb	7440-36-0
Arsenic	As	7440-38-2
Barium	Ba	7440-39-3
Beryllium	Be	7440-41-7
Cadmium	Cd	7440-43-9
Calcium	Ca	7440-70-2
Chromium	Cr	7440-47-3
Cobalt	Co	7440-48-4
Copper	Cu	7440-50-8
Iron	Fe	7439-89-6
Lead	Pb	7439-92-1
Magnesium	Mg	7439-95-4
Manganese	Mn	7439-96-5
Molybdenum	Mo	7439-98-7
Nickel	Ni	7440-02-0
Potassium	K	7440-09-7
Selenium	Se	7782-49-2
Silver	Ag	7440-22-4
Sodium	Na	7440-23-5
Thallium	Tl	7440-28-0
Vanadium	V	7440-62-2
Zinc	Zn	7440-66-6

TABLE II. ICP and FLAA Soil Matrix Spike and Aqueous LCS Levels

ELEMENT	Working LCS/MS Standard (mg/L)	Aqueous LCS/MS Level* (ug/L)	Soil MS Level ** (mg/Kg)
Aluminum	100	2000	200
Antimony	25	500	50
Arsenic	100	2000	200
Barium	100	2000	200
Beryllium	2.5	50	5
Cadmium	2.5	50	5
Calcium	2500	50000	5000
Chromium	10	200	20
Cobalt	25	500	50
Copper	12.5	250	25
Iron	50	1000	100
Lead	25	500	50
Lithium	50	1000	100
Magnesium	2500	50000	5000
Manganese	25	500	50
Molybdenum	50	1000	100
Nickel	25	500	50
Potassium	2500	50000	5000
Selenium	100	2000	200
Silver	2.5	50	5
Sodium	2500	50000	5000
Strontium	50	1000	100
Thallium	100	2000	200
Vanadium	25	500	50
Zinc	25	500	50
Boron	50	1000	100
Tin	100	2000	200
Titanium	50	1000	100

* Levels shown indicate the spike concentration in the final digestate of the aqueous LCS or matrix spike based on the addition of 2.0 mL working spike (7.3) to 100 mL of sample.

** Final soil spike concentration based on the addition of 2.0 mL working spike (7.3) to 1.0 g of sample/100 mL final volume (assumes 100% solids).

TABLE III. ICPMS Soil Matrix Spike and Aqueous LCS Levels

ELEMENT	Working LCS/MS Standard (mg/L)	Aqueous LCS/MS Level* (ug/L)	Soil MS Level ** (mg/Kg)
Aluminum	100	1000	100
Antimony	10	100	10
Arsenic	10	100	10
Barium	10	100	10
Beryllium	10	100	10
Cadmium	10	100	10
Calcium	100	1000	100
Chromium	10	100	10
Cobalt	10	100	10
Copper	10	100	10
Iron	100	1000	100
Lead	10	100	10
Magnesium	100	1000	100
Manganese	10	100	10
Molybdenum	10	100	10
Nickel	10	100	10
Potassium	100	1000	100
Selenium	10	100	10
Silver	10	100	10
Sodium	100	1000	100
Strontium	10	100	10
Thallium	10	100	10
Vanadium	10	100	10
Zinc	10	100	10
Boron	10	100	10
Tin	10	100	10
Titanium	10	100	10
Zirconium	10	100	10

* Levels shown indicate the spike concentration in the final digestate of the aqueous LCS or matrix spike based on the addition of 1.0 mL working spike (7.4) to 100 mL of sample.

** Final soil spike concentration based on the addition of 1.0 mL working spike (7.4) to 1.0 g of sample/100 mL final volume (assumes 100% solids).

TABLE IV. GFAA Soil Matrix Spike and Aqueous LCS Spike Levels

ELEMENT	Stock LCS/MS Standard (mg/L)	Working LCS/MS Standard (ug/L)	Aqueous LCS/ MS Level * (ug/L)	Soil MS Level** (mg/Kg)
Arsenic	400	2000	40	4
Selenium	400	2000	40	4
Lead	400	2000	40	4
Thallium	400	2000	40	4
Antimony	400	2000	40	4
Cadmium	40	200	4	0.4
Chromium	100	500	10	1
Silver	50	250	5	0.5

* Levels shown indicate the spike concentration in the final digestate of the aqueous LCS or matrix spike based on the addition of 1.0 mL working spike (7.5) to 50 mL of sample.

** Final soil spike concentration based on the addition of 2.0 mL working spike (7.5) to 1.0 g of sample/100 mL final volume (assumes 100% solids).

TABLE V. Summary of Quality Control Requirements

QC PARAMETER	FREQUENCY	ACCEPTANCE CRITERIA	CORRECTIVE ACTION
Method Blank	One per sample preparation batch of up to 20 samples.	Refer to determinative SOPs: NC-MT-0002 CORP-MT-0001 CORP-MT-0003	Redigest and reanalyze samples.
Laboratory Control Sample (LCS)	One per sample preparation batch of up to 20 samples.	Refer to determinative SOPs: NC-MT-0002 CORP-MT-0001 CORP-MT-0003	Redigest and reanalyze all samples associated with the LCS.
Matrix Spike	One per sample preparation batch of up to 20 samples.	Refer to determinative SOPs: NC-MT-0002 CORP-MT-0001 CORP-MT-0003	Reprep not required unless preparation error suspected.
Matrix Spike Duplicate	See Matrix Spike	Refer to determinative SOPs: NC-MT-0002 CORP-MT-0001 CORP-MT-0003	See Corrective Action for Matrix Spike.

APPENDIX B

CONTAMINATION CONTROL GUIDELINES

APPENDIX B. CONTAMINATION CONTROL GUIDELINES

The following procedures are strongly recommended to prevent contamination:

All work areas used to prepare standards and spikes should be cleaned before and after each use.

All glassware should be washed with detergent and tap water and rinsed with 1:1 nitric acid followed by deionized water.

Proper laboratory housekeeping is essential in the reduction of contamination in the metals laboratory. All work areas must be kept scrupulously clean.

Powdered or latex gloves must not be used in the metals laboratory since the powder contains silica and zinc, as well as other metallic analytes. Only vinyl or nitrile gloves should be used in the metals laboratory.

Glassware should be periodically checked for cracks and etches and discarded if found. Etched glassware can cause cross contamination of any metallic analytes.

Autosampler trays should be covered to reduce the possibility of contamination. Trace levels of elements being analyzed in the samples can be easily contaminated by dust particles in the laboratory.

The following are helpful hints in the identification of the source of contaminants:

Reagents or standards can contain contaminants or be contaminated with the improper use of a pipette.

Improper cleaning of glassware can cause contamination.

Separate glassware if an unusually high sample is analyzed and soak with sulfuric acid prior to routine cleaning.

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SOP No. CORP-MT-0001NC
Revision No. 3.4
Revision Date: 01/08/04
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STL NORTH CANTON STANDARD OPERATING PROCEDURE

TITLE: INDUCTIVELY COUPLED PLASMA-ATOMIC EMISSION SPECTROSCOPY, SPECTROMETRIC METHOD FOR TRACE ELEMENT ANALYSES, SW-846 METHOD 6010B AND EPA METHOD 200.7

(SUPERSEDES: REVISION 3.3, REVISION DATE (12/05/01)

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1. SCOPE AND APPLICATION

1.1. This procedure describes the analysis of trace elements including metals in solution by Inductively Coupled Plasma -Atomic Emission Spectroscopy (ICP-AES) using SW-846 Method 6010B and EPA Method 200.7 . Table I of Appendix A lists the elements appropriate for analysis by Methods 6010B and 200.7. Additional elements may be analyzed under Methods 6010B and 200.7 provided that the method performance criteria presented in Section 13.0 are met.

1.2. ICP analysis provides for the determination of metal concentrations over several orders of magnitude. Detection limits, sensitivity and optimum concentration ranges of the metals will vary with the matrices and instrumentation used.

1.3. Method 6010B is applicable to the determination of dissolved, suspended, total recoverable and total elements in ground water, aqueous samples, soils, sludges, wastes, sediments, biological, and TCLP, EP and other leachates/extracts. All matrices require digestion prior to analysis with the exception of analyses for dissolved metals in filtered and acidified aqueous samples. Although digestion is not specifically required by the method, some clients and regulators may require digestion of **dissolved samples** and this must be clarified and documented before project initiation. Silver concentrations must be below 2.0 mg/L in aqueous samples and 100 mg/kg in solid matrix samples. Precipitation may occur in samples where silver concentrations exceed these levels and lead to the generation of erroneous data.

1.4. Method 200.7 is applicable to the determination of dissolved, suspended, total recoverable, and total elements in water, waste water, and solid wastes. All matrices require digestion prior to analysis with the exception of analyses for dissolved metals in filtered and acidified aqueous samples if the criteria in Section 11.1 are met. Silver concentrations must be below 0.1 mg/L in aqueous samples.

1.5. State-specific requirements may take precedence over this SOP for drinking water sample analyses.

1.6. The applicable LIMS method codes are QO (6010B), QM (6010B Trace), AS (200.7), JI (200.7 Trace). The Trivalent Chromium method code is GU.

2. SUMMARY OF METHOD

2.1. This method describes a technique for the determination of multi elements in solution using sequential or simultaneous optical systems and axial or radial viewing of the plasma. The basis of the method is the measurement of atomic emission by an optical spectroscopic technique. Samples are nebulized and the aerosol that is produced is transported to the plasma torch where excitation occurs. Characteristic atomic-line

emission spectra are produced by a radio frequency inductively coupled plasma (ICP). The spectra are dispersed by a grating spectrometer and the intensities of the emission lines are monitored by photomultiplier tubes. The photocurrents from the photomultiplier tubes are processed and controlled by a computer system. A background correction technique is required to compensate for variable background contribution to the determination of trace elements. Background must be measured adjacent to analyte lines during analysis. The position selected for the background intensity measurement, on either or both sides of the analytical line, will be determined by the complexity of the spectrum adjacent to the analyte line. The position used must be free of spectral interferences and reflect the same change in background intensity as occurs at the analyte wavelength measured. Background correction is not required in cases of line broadening where a background correction measurement would actually degrade the analytical result. The possibility of additional interferences should also be recognized and appropriate actions taken. Alternatively, multivariate calibration methods may be chosen for which point selection for background correction is superfluous since whole spectral regions are processed.

2.2. Refer to CORP-IP-0002NC, Acid Digestion of Soils, SW846 Method 3050B and CORP-IP-0003NC, Acid Digestion of Aqueous Samples by SW846 and MCAWW 200 Series Methods for details on sample preparation methods.

3. DEFINITIONS

3.1. Dissolved Metals: Those elements which pass through a 0.45 um membrane. (Sample is acidified after filtration).

3.2. Suspended Metals: Those elements which are retained by a 0.45 um membrane.

3.3. Total Metals: The concentration determined on an unfiltered sample following vigorous digestion.

3.4. Total Recoverable Metals: The concentration determined on an unfiltered sample following treatment with hot, dilute mineral acid.

4. INTERFERENCES

4.1. Spectral, physical and chemical interference effects may contribute to inaccuracies in the determinations of trace elements by ICP. Spectral interferences are caused by:

- Overlap of a spectral line from another element.
- Unresolved overlap of molecular band spectra.

- Background contribution from continuous or recombination phenomena.
- Stray light from the line emission of high concentration elements.

4.1.1. A background correction technique is required to compensate for variable background contribution to the determination of trace elements. Background correction is not required in cases where a background corrective measurement would actually degrade the analytical result.

4.1.2. Inter-element correction factors (IECs) are necessary to compensate for spectral overlap. Inter-element interferences occur when elements in the sample emit radiation at wavelengths so close to that of the analyte that they contribute significant intensity to the analyte channel. If such conditions exist, the intensity contributed by the matrix elements will cause an excessively high (or sometimes low) concentration to be reported for the analyte. Inter-element corrections IECs must be applied to the analyte to remove the effects of these unwanted emissions.

4.1.3. Physical interferences are generally considered to be effects associated with sample transport, nebulization and conversion within the plasma. These interferences may result in differences between instrument responses for the sample and the calibration standards. Physical interferences may occur in the transfer of solution to the nebulizer (e.g., viscosity effects), at the point of aerosol formation and transport to the plasma (e.g., surface tension) or during excitation and ionization processes within the plasma itself. Changes in viscosity and surface tension can cause significant inaccuracies, especially in samples containing high dissolved solids or high acid concentrations. If physical interferences are present, dilution of the sample, use of a peristaltic pump, mass flow controller, use of an internal standard and/or use of a high solids nebulizer can reduce the effect.

4.1.4. Chemical interferences are characterized by molecular compound formation, ionization effects and solute vaporization effects. Normally these effects are not significant with the ICP technique but if observed can be minimized by buffering the sample, matrix matching or standard addition procedures.

5. SAFETY

5.1. Employees must abide by the policies and procedures in the Corporate Safety Manual, Radiation Safety Manual and this document.

5.2. Eye protection that protects against splash, laboratory coat, and appropriate gloves must be worn while samples, standards, solvents, and reagents are being handled. Disposable gloves

that have been contaminated will be removed and discarded; other gloves will be cleaned immediately.

5.3. The following is a list of the materials used in this method, which have a serious or significant hazard rating. **NOTE: This list does not include all materials used in the method. The table contains a summary of the primary hazards listed in the MSDS for each of the materials listed in the table.** A complete list of materials used in the method can be found in the reagents and materials section. Employees must review the information in the MSDS for each material before using it for the first time or when there are major changes to the MSDS.

Material (1)	**Hazards**	**Exposure Limit (2)**	**Signs and symptoms of exposure**
Nitric Acid	Corrosive Oxidizer Poison	2 ppm-TWA 4-ppm STEL	Nitric acid is extremely hazardous; it is corrosive, reactive, an oxidizer, and a poison. Inhalation of vapors can cause breathing difficulties and lead to pneumonia and pulmonary edema, which may be fatal. Other symptoms may include coughing, choking, and irritation of the nose, throat, and respiratory tract. Can cause redness, pain, and severe skin burns. Concentrated solutions cause deep ulcers and stain skin a yellow or yellow-brown color. Vapors are irritating and may cause damage to the eyes. Contact may cause severe burns and permanent eye damage.
Hydrochloric Acid	Corrosive Poison	5 ppm-Ceiling	Inhalation of vapors can cause coughing, choking, inflammation of the nose, throat, and upper respiratory tract, and in severe cases, pulmonary edema, circulatory failure, and death. Can cause redness, pain, and severe skin burns. Vapors are irritating and may cause damage to the eyes. Contact may cause severe burns and permanent eye damage.
1 – Always add acid to water to prevent violent reactions			
2 – Exposure limit refers to the OSHA regulatory exposure limit.			

5.3.1. The plasma emits strong UV light and is harmful to vision. **NOTE**: **AVOID looking directly at the plasma**.

5.3.2. The RF generator produces strong radio frequency waves, most of which are unshielded. People with pacemakers should not go near the instrument while in operation.

5.4. Exposure to chemicals must be maintained **as low as reasonably achievable**, therefore, unless they are known to be non-hazardous, all samples should be opened, transferred and prepared in a fume hood, or under other means of mechanical ventilation. Metals digestates can be processed outside of a fume hood. Solvent and waste containers will be kept closed unless transfers are being made.

5.5. All work must be stopped in the event of a known or potential compromise to the health and safety of a STL North Canton associate. The situation must be reported **immediately** to a laboratory supervisor.

6. EQUIPMENT AND SUPPLIES

6.1. Inductively Coupled Plasma Atomic Emission Spectrometer equipped with autosampler and background correction.

6.2. Radio Frequency Generator.

6.3. Argon gas supply, welding grade or equivalent.

6.4. Coolflow or appropriate water cooling device.

6.5. Peristaltic Pump.

6.6. Calibrated automatic pipettes or Class A glass volumetric pipettes.

6.7. Class A volumetric flasks.

6.8. Autosampler tubes.

7. REAGENTS AND STANDARDS

7.1. Intermediate standards are purchased as custom STL North Canton multi-element mixes or as single-element solutions. All standards must be stored in FEP fluorocarbon or unused polyethylene or polypropylene bottles. Intermediate standard solutions must be replaced prior to the expiration date provided by the manufacturer. If no expiration date is provided,

the intermediate solutions may be used for up to one year and must be replaced sooner if verification from an independent source indicates a problem. Expiration dates can be extended provided that the acceptance criteria described in laboratory-specific SOPs are met.

7.2. Working calibration and calibration verification solutions may be used for up to 3 months and must be replaced sooner if verification from an independent source indicates a problem. Standards should be prepared in a matrix of 5% hydrochloric and 5% nitric acids. Refer to Tables III, IV, IVA, V and VI (Appendix A) for details regarding the working standard concentrations for calibration, calibration verification, interference correction and spiking solutions.

7.3. Concentrated nitric acid (HNO_3), trace metal grade or better.

7.4. Concentrated hydrochloric acid (HCl), trace metal grade or better.

7.5. Reagent water must be produced by a Millipore DI system or equivalent. Reagent water must be free of the analytes of interest as demonstrated through the analysis of method blanks.

8. SAMPLE COLLECTION, PRESERVATION AND STORAGE

8.1. Sample holding times for metals are six months from time of collection to the time of analysis.

8.2. Aqueous samples are preserved with nitric acid to a pH of <2 and may be stored in either plastic or glass. If boron or silica are to be determined, plastic containers are preferred. Refrigeration is not required. Preservation must be verified prior to analysis.

8.3. Soil samples do not require preservation but must be stored at 4°C ± 2° until the time of preparation .

9. QUALITY CONTROL

Table VII (Appendix A) provides a summary of quality control requirements including type, frequency, acceptance criteria and corrective action.

9.1. Initial Demonstration of Capability

9.1.1. Prior to analysis of any analyte using either Method 200.7 or Method 6010B, the following requirements must be met.

9.1.2. Instrument Detection Limit (IDL) - The IDL for each analyte must be determined for each analyte wavelength used for each instrument. The IDL must be determined

annually. If the instrument is adjusted in anyway that may affect the IDL, the IDL for that instrument must be redetermined. The IDL shall be determined by multiplying by 3, the standard deviation obtained from the analysis of a blank solution, with seven consecutive measurements. Each measurement must be performed as though it were a separate analytical sample (i.e., each measurement must be followed by a rinse and/or any other procedure performed between the analysis of separate samples). The result of the IDL determination must be below the STL North Canton reporting limit. The CLP IDL procedure can be used for this method.

9.1.3. Method Detection Limit (MDL) - An MDL must be determined for each analyte prior to the analysis of any client samples. Refer to STL North Canton SOP NC-QA-0021 for details on MDL analysis and criteria.

9.1.4. Linear Range Verification (LR) - The linear range must be verified every 6 months on at least an annual basis for each analyte wavelength used on each instrument. The linear range is the concentration above which results cannot be reported without dilution of the sample. The standards used to verify the linear range limit must be analyzed during a routine analytical run and must read within 5% of the expected value.

For the **initial** determination of the upper limit of the linear dynamic range (LDR) for each wavelength, determine the signal responses from a minimum of three to five different concentration standards across the estimated range. One standard should be near the upper limit of the estimated range. The concentration measured at the LDR must be no more than 10% less than the expected level extrapolated from lower standards. If the instrument is adjusted in any way that may affect the LRs, new dynamic ranges must be determined. The LR data must be documented and kept on file.

9.1.5. Background Correction Points - To determine the appropriate location for off-line background correction when establishing methods, the user must scan the area on either side adjacent to the wavelength and record the apparent emission intensity from all other method analytes. This spectral information must be documented and kept on file. The location selected for background correction must be either free of off-line interelement spectral interference or a computer routine must be used for automatic correction on all determinations. Tests to determine spectral interference must be done using analyte concentrations that will adequately describe the interference. Background correction points must be set prior to determining IECs. Refer to the ICP instrument manual for specific procedures to be used in setting background correction points.

9.1.6. Inter-element Corrections (IECs) - ICP interelement correction factors must be determined prior to the analysis of samples and every six months thereafter. If the instrument is adjusted in any way that may affect the IECs, the IECs must be redetermined. When initially determining IECs for an instrument, wavelength scans must be performed to ensure that solutions in use are free from contaminants. If an IEC varies significantly from the previously determined IEC then the possibility of contamination should be investigated. The purity of the IEC check solution can be verified by using a standard from a second source or an alternate method (i.e., GFAA or ICP-MS). Published wavelength tables (e.g. MIT tables, Inductively Coupled Plasma-Atomic Spectroscopy: Prominent Lines) can also be consulted to

evaluate the validity of the IECs. Refer to the instrument manufacturer's recommendations for specific procedures to be used in setting IECs. An IEC must be established to compensate for any interelement interference which results in a false analyte signal greater than ± the RL as defined in Tables I, IA or II. For elements with a reporting limit 10 ug/L or less, the signal should be ± 2X the RL. To determine IECs, run a single element standard at the established linear range. To calculate an IEC, divide the observed concentration of the analyte by the actual concentration of the "interfering element."

Note: Trace ICP IECs are more sensitive to small changes in the plasma and instrument setup conditions. Adjustments in the IECs will be required on a more frequent basis for the Trace as reflected by the ICSA response. Additional spectral interference is present from easily ionizable elements such as potassium and sodium in axial viewing instruments.

9.1.7. Rinse Time Determination - Rinse times must be determined upon initial set-up of an ICP instrument. To determine the appropriate rinse time for a particular ICP system, the linear range verification standard (see 9.1.4) should be aspirated as a regular sample followed by the analysis of a series of rinse blanks. The length of time required to reduce the analyte signals to < RL will define the rinse time for a particular ICP system. For some analytes it may be impractical to set the rinse time based on the linear range standard result (i.e., analyte not typically detected in environmental samples at that level and an excessive rinse time would be required at the linear range level). Until the required rinse time is established, the method recommends a rinse period of at least 60 seconds between samples and standards. If a memory effect is suspected, the sample must be reanalyzed after a rinse period of sufficient length. Rinse time studies can be conducted at additional concentration levels. These additional studies must be documented and kept on file, if a concentration other than the linear range level is used to set the rinse time. The concentration levels used to establish the rinse time must be taken into consideration when reviewing the data.

9.2. Method Blank (MB) - One method blank must be processed with each preparation batch. The method blank consists of reagent water containing all reagents specific to the method that is carried through the entire analytical procedure, including preparation and analysis. The method blank is used to identify any system and process interferences or contamination of the analytical system that may lead to the reporting of elevated analyte concentrations or false positive data. The method blank should not contain any analyte of interest at or above the reporting limit (exception: common laboratory contaminants, see below) or at or above 5% of the measured concentration of that analyte in associated samples, whichever is higher (sample result must be a minimum of 20x higher than the blank contamination level).

- If the analyte is a common laboratory contaminant (copper, iron, lead (Trace only) or zinc) the data may be reported with qualifiers if the concentration of the analyte in the method blank is less than two times the RL. Such action must be addressed in the project narrative.

- Repreparation and reanalysis of all samples associated with an unacceptable method blank is required when reportable concentrations are determined in the samples (see exception noted above).

- If there is no analyte greater than the RL in the samples associated with an unacceptable method blank, the data may be reported with qualifiers. Such action must be addressed in the project narrative.

- If the above criteria are not met and reanalysis is not possible, then the sample data must be qualified. This anomaly must be addressed in the project narrative.

- For dissolved metals samples which have not been digested, a CCB result is reported as the method blank. The CCB run immediately prior to the start of the dissolved sample analyses must be used for this purpose. No more than 20 samples can be associated with one CCB.

9.3. Laboratory Control Sample (LCS) - One aqueous LCS must be processed with each preparation batch. The LCS must contain all analytes of interest and must be carried through the entire analytical procedure. Aqueous LCS spike levels are provided in Table III (Appendix A). The LCS is used to monitor the accuracy of the analytical process. On-going monitoring of the LCS results provides evidence that the laboratory is performing the method within acceptable accuracy and precision guidelines.

- If any analyte is outside established control limits the system is out of control and corrective action must occur. Unless in-house control limits are established, a control limit of 80 - 120% recovery must be applied.

- In the event that an MS/MSD analysis is not possible a Laboratory Control Sample Duplicate (LCSD) must be analyzed. The RPD of the LCS and LCSD must be compared to the matrix spike RPD limits.

- In the instance where the LCS recovery is greater than 120% and the sample results are < RL, the data may be reported with qualifiers. Such action must be addressed in the report narrative.

- Corrective action will be repreparation and reanalysis of the batch unless the client agrees that other corrective action is acceptable.

- For dissolved metals samples which have not been digested, a CCV result is reported as the LCS. The CCV run immediately prior to the start of the dissolved sample analyses must be used for this purpose. No more than 20 samples can be associated with one CCV.

9.4. Matrix Spike/Matrix Spike Duplicate (MS/MSD) - One MS/MSD pair must be processed for each preparation batch. A matrix spike (MS) is a field sample to which known concentrations of target analytes have been added. A matrix spike duplicate (MSD) is a second aliquot of the same sample (spiked identically as the MS) prepared and analyzed along with the sample and matrix spike. Some client specific data quality objectives (DQO's) may require the use of sample duplicates in place of or in addition to MS/MSDs. The MS/MSD results are used to determine the effect of a matrix on the precision and accuracy of the analytical process. Due to the potential variability of the matrix of each sample, these results may have immediate bearing only on the specific sample spiked. Samples identified as field blanks cannot be used for MS/MSD analysis. Spiking levels are provided in Tables III and VI (Appendix A).

- If any analyte recovery or RPD falls outside the acceptance range, the recovery of that analyte must be in control for the LCS. For both methods 200.7 and 6010B, control limits of 75-125% recovery and 20% RPD or historical acceptance criteria must be applied to the MS/MSD. If the LCS recovery is within limits, then the laboratory operation is in control and the results may be accepted. If the recovery of the LCS is outside limits corrective action must be taken. Corrective action will include repreparation and reanalysis of the batch. MS/MSD results which fall outside the control limits must be addressed in the narrative.

- If the native analyte concentration in the MS/MSD exceeds 4x the spike level for that analyte, the recovery data are reported as NC, MSB (i.e., not calculated). Two other narrative notes for metals analyses: Matrix spike/spike duplicate spike recovery/recoveries was/were outside the acceptance limits of some analytes. The acceptable LCS analysis data indicated that the analytical system was operating within control and this condition is most likely due to matrix interference. See the Matrix Spike Report for the affected analytes which will be flagged with N. Matrix spike/spike duplicate relative percent difference (RPD) exceeded the acceptance limits for some analytes. The imprecision may be attributed to sample heterogeneity. See the Matrix Spike Report for the affected analytes, which will be flagged with *.

- If an MS/MSD is not possible due to limited sample volume then a laboratory control sample duplicate (LCSD) should be analyzed. The RPD of the LCS and LCSD must be compared to the matrix spike RPD limits.

- For dissolved metals samples which have not been digested, a MS/MSD must be performed per batch of up to 20 samples by spiking two aliquots of the sample at the levels specified in Table III (Appendix A).

9.5. Dilution test – A dilution test is performed to determine whether significant physical or chemical interferences exist due to the sample matrix. One sample per preparation batch must be processed as a dilution test. The test is performed by running a sample at a 5x (1:4) dilution. Samples identified as field blanks cannot be used for dilution tests. The results of the diluted sample, after correction for dilution, should agree within 10% of the original sample determination when the original sample concentration is greater than 50x the IDL. If the results are not within 10%, the possibility of chemical or physical interference exists and the data is flagged.

9.6. Initial Calibration Verification (ICV/ICB) - Calibration accuracy is verified by analyzing a second source standard (ICV). For analyses conducted under Method 200.7, the ICV result must fall within 5% of the true value for that solution with relative standard deviation <3% from replicate (minimum of two) exposures. For Method 6010B, the ICV must fall within 10% of the true value for that solution with relative standard deviation <5% from replicate (minimum of two) exposures. An ICB is analyzed immediately following the ICV to monitor low level accuracy and system cleanliness. The ICB result must fall within +/- the RL from zero. If either the ICV or ICB fail to meet criteria, the analysis should be terminated, the problem corrected, the instrument recalibrated and the calibration reverified. (See Section 11.8 or 11.11 for required run sequence).

9.7. Continuing Calibration Verification (CCV/CCB) - Calibration accuracy is monitored throughout the analytical run through the analysis of a known standard after every 10 samples and at the end of the sample run. The CCV is be a mid-range standard made from a dilution of the calibration standard. The CCV for both methods must fall within 10% of the true value for that solution with relative standard deviation <5% from replicate (minimum of two) exposures. A CCB is analyzed immediately following each CCV. (See Section 11.8 or 11.11 for required run sequence.) The CCB result must fall within +/- RL from zero. If the blank is less than 1/10 the concentration of the action level of interest, and no sample is within 10% of the action limit, reanalysis and recalibration are not required before continuation of the run. Sample results may only be reported when bracketed by valid CCV/CCB pairs. If a mid-run CCV or CCB fails, all affected samples will be re-analyzed with valid CCV/CCB pairs. (Refer to Section 11.13 for an illustration of the appropriate rerun sequence).

9.8. Interference Check Analysis (ICSA/ICSAB) - The validity of the interelement correction factors is demonstrated through the successful analysis of interference check solutions. The ICSA contains only interfering elements, the ICSAB contains analytes and interferents. Refer to Table V (Appendix A) for the details of ICSA and ICSAB composition. Custom

STL North Canton multielement ICS solutions must be used. All analytes should be spiked into the ICSAB solution, therefore, if a non-routine analyte is required then it should be manually spiked into the ICSAB using a certified ultra high purity single element solution or custom lab-specific mix. If the ICP will display overcorrection as a negative number then the non-routine elements can be controlled from the ICSA as described in section 9.8.3. Elements known to be interferents on a required analyte must be included in the ICP run when that analyte is determined. Aluminum, iron, calcium and magnesium must always be included in all ICP runs.

9.8.1. The ICSA and ICSAB solutions must be run at the beginning of the run. (See Section 11.10 or 11.13 for required run sequence.)

9.8.2. The ICSAB results for the interferents must fall within 80 - 120% of the true value. If any ICSAB interferent result fails criteria, the analysis should be terminated, the problem corrected, the instrument recalibrated and the samples rerun.

9.8.3. ICSA results for the non-interfering elements with reporting limits ≤ 10 ug/L must fall within the STL North Canton guidelines of ± 2x RL from zero. ICSA results for the non-interfering elements with RLs> 10 µg/L must fall within the STL North Canton guidelines of ± 1x RL from zero. If the ICSA results for the non-interfering elements do not fall within +/- 2x RL (RL ≤10) or ± 1xRL (RL>10) from zero the field sample data must be evaluated as follows:

- If the non-interfering element concentration in the ICSA is the result of contamination versus a spectral interference, and this reason is documented, the field sample data can be accepted.
- If the affected element was not required then the sample data can be accepted.
- If the interfering elements are not present in the field sample at a concentration which would result in a false positive or negative result greater than +/- 2x RL from zero then the field sample data can be accepted.
- If the interfering element is present in the field sample at a level which would result in a false analyte signal greater than ± 2x RL from zero, the data can be accepted only if the concentration of the affected analyte in the field sample is more than 10x the analyte signal in the ICSA.
- If the data does not meet the above conditions then the IECs must be re-evaluated and corrected if necessary and the affected samples reanalyzed or the sample results manually corrected through application of the new IEC to the

raw results. If the results are recalculated manually the calculations must be clearly documented on the raw data.

9.9. CRI - To verify linearity near the RL for ICP analysis, a CRI standard is run at the beginning of each sample analysis run. Additionally, some projects may require CRI analysis at the end of the run. (See Section 11.10 or 11.13 for required run sequence.) Evaluate associated samples based upon advisory limits of +/- 50% of true value.

Note: The custom STL North Canton CRI mix contains most analytes at a level near the standard lab reporting limit.

Note: For certified Ohio drinking water analysis, the CRI concentration must be at or below the reporting limit and must recover at ± 30% of true value.

9.10. Method of Standard Addition (MSA) -This technique involves adding known amounts of standard to one or more aliquots of the processed sample solution. This technique compensates for a sample interferent that may enhance or depress the analyte signal, thus producing a different slope from that of the calibration standards. It will not correct for additive interferences which cause a baseline shift. Refer to Section 11.17 for additional information on when MSA is required as well as Appendix C for specific MSA requirements.

10. CALIBRATION AND STANDARDIZATION

10.1. Set up the instrument with the operating parameters recommended by the manufacturer. Allow the instrument to become thermally stable before beginning calibration (approximately 30 minutes of warm-up is required). Refer to the instructions in Appendix G.

10.2. Profile and calibrate the instrument according to the instrument manufacturer's recommended procedures. Flush the system with the calibration blank between each standard or as the manufacturer recommends. The calibration curve must consist of a minimum of a blank and a standard. Refer to Appendix G for detailed set up and operation protocols.

10.3. Calibration must be performed daily and each time the instrument is set up. Instrument runs may be continued over periods exceeding 24 hours as long as all calibration verification (CCV) and interference check QC criteria are met. The instrument standardization date and time must be included in the raw data.

10.4. Refer to Section 9.0 for calibration verification procedures, acceptance criteria and corresponding corrective actions.

11. PROCEDURE

11.1. For 200.7 analyses, dissolved (preserved) samples must be digested unless it can be documented that the sample meets all of the following criteria:

A. Visibly transparent with a turbidity measurement of 1 NTU or less.

B. Is of one liquid phase and free of particulate or suspended matter following acidification.

C. Is NOT being analyzed for silver.

11.2. A minimum of two exposures for each standard, field sample and QC sample is required. The average of the exposures is reported. For Trace ICP analyses, the results of the sum channel must be used for reporting.

11.3. Prior to calibration and between each sample/standard the system is rinsed with the calibration blank solution. The minimum rinse time between analytical samples is 60 seconds unless following the protocol outlined in 9.1.5 it can be demonstrated that a shorter rinse time may be used.

11.4. The use of automated QC checks through the instrument software is highly recommended for all calibration verification samples (ICV,CCV), blanks (ICB,CCB,PB), interference checks (ICSA,ICSAB) and field samples (linear range) to improve the data review process.

11.5. To facilitate the early identification of QC failures and samples requiring rerun it is strongly recommended that sample data be reviewed periodically throughout the run.

11.6. To facilitate the data review and reporting processes it is strongly recommended that all necessary dilutions be performed before closing out the instrument run.

11.7. The use of an internal standard is **required** on the Trace ICP unless the calibration and QC standards are matrix matched to each digestion procedure used as follows:

Preparation Method	% HNO_3	% HCl
CLP Aqueous	1	5
CLP Soil	5	2.5
SW846 3050	10	10
SW846 3005	2	5

SW846 3010	6	5

The following procedural guidelines must be followed when using an internal standard:

11.7.1. Typically used internal standards are: yttrium. (Note: Any element can be used that is not typically found in environmental samples at a high rate of occurrence.)

11.7.2. The internal standard (IS) must be added to every sample and standard at the same concentration. It is recommended that the IS be added to each analytical sample automatically through use of a third pump channel and mixing coil. Internal standards should be added to blanks, samples and standards in a like manner, so that dilution effects resulting from the addition may be disregarded.

11.7.3. The concentration of the internal standard should be sufficiently high to obtain good precision in the measurement of the IS analyte used for data correction and to minimize the possibility of correction errors if the IS analyte is naturally present in the sample.

11.7.4. The internal standard raw intensity counts must be printed on the raw data.

11.7.5. The analyst must monitor the response of the internal standard throughout the sample analysis run. This information is used to detect potential problems and identify possible background contributions from the sample (i.e., natural occurrence of IS analyte). The instrument automatically adjusts sample results based on comparison of the internal standard intensity in the sample to the internal standard intensity at calibration.

11.7.5.1. If the internal standard counts fall within ±30% of the counts observed in the ICB then the data is acceptable.

11.7.5.2. If the internal standard counts in the field samples are more than ±30% higher than the expected level, the field samples must then be diluted and reanalyzed.

11.8. The following analytical sequence must be used for Methods 6010B and 200.7:

Instrument Calibration
ICV
ICB
CRI

ICSA
ICSAB
7 samples
CCV
CCB
10 samples
CCV
CCB
Repeat sequence of up to 10 samples between CCV/CCB pairs as required to complete run
CRI (The CRI counts as a sample analysis.)
CCV
CCB

Refer to Quality Control Section 9.0 and Table VII (Appendix A) for Method 6010B and 200.7 quality control criteria.

11.9. Additional quality control analyses are necessary for analysis under the Contract Laboratory Program (CLP). If these are included then CLP, 6010 and 200.7 samples can be included in the same sequence. Refer to CORP-MT-0002NC for details.

11.10. Full method required QC must be available for each wavelength used in determining reported analyte results.

11.11. The following run sequence provides an illustration of a mid-run CCV or CCB failure and the appropriate corrective action run sequence as described in Section 9.7:

Original Run: Instrument Calibration

ICV

ICB

CRI

ICSA

ICSAB

7 samples

CCV1

CCB1

10 samples

CCV2

CCB2

10 samples **

CCV3 * * Failure occurs at CCV3/CCB3

CCB3 * **Samples requiring rerun for affected analytes

10 samples **

CCV4

CCB4

10 samples

CCV5

CCB5

Reanalysis: Recalibrate

ICV

ICB

CRI

ICSA

ICSAB

CCV2

CCB2

10 samples

CCV3

CCB3

10 samples

CCV4

CCB4

Notes: Samples between CCV4 and CCV5 do not require reanalysis as they were bracketed by compliant QC samples.

See CORP-MT-0002NC for the appropriate reanalysis sequence if CLP requirements must also be met.

11.14 The instrument may be reprofiled between CCV/CCB pairs to correct for environment induced drift.

11.15 Guidelines are provided in the appendices on procedures to minimize contamination of samples and standards, preventive maintenance and troubleshooting.

11.16 All measurements must fall within the defined linear range where spectral interference correction factors are valid. Dilute and reanalyze all samples for required analytes that exceed the linear range or use an alternate wavelength for which QC data are established. If an interelement correction exists for an analyte which exceeds the linear range, the IEC may be inaccurately applied. Therefore, even if an overrange analyte may not be required to be reported for a sample, if that analyte is a interferent for any requested analyte in that sample, the sample must be diluted. Acid strength must be maintained in the dilution of samples.

11.17 For TCLP samples, full four-point MSA will be required if all of the following conditions are met:

1) recovery of the analyte in the matrix spike is not at least 50%,

2) the concentration of the analyte does not exceed the regulatory level, and,

3) the concentration of the analyte is within 20% of the regulatory level.

The reporting and regulatory limits for TCLP analyses as well as matrix spike levels are detailed in Table VI (Appendix A). Appendix C provides guidance on performing MSA analyses.

11.18 Any variation in procedure shall be completely documented using instrument run logs, maintenance logs, report narratives, a Nonconformance Memo, or an anomaly report and

is approved by a Supervisor/Group Leader and QA Manager. If contractually required, the client shall be notified by the Project Manager.

11.19 Nonconformance documentation shall be filed in the project file.

11.20 Any unauthorized deviations from this procedure must also be documented as a nonconformance, with a cause and corrective action described.

11.21 Analytical Documentation

11.21.1 Record all analytical information in the analytical logbook/logsheet which may be in an electronic format, including the analytical data from standards, blanks, LCSs, MS/MSDs, and any corrective actions or modifications to the method.

11.21.2 All standards are logged into a department standard logbook. All standards are assigned an unique number for identification. Logbooks are reviewed by the supervisor or designee.

11.21.3 Documentation such as all associated instrument printouts (final runs, screens, reruns, QC samples, etc.) and daily calibration data corresponding to all final runs is available for each data file.

11.21.4 Sample results and associated QC are entered into the LIMs after final technical review.

12 DATA ANALYSIS AND CALCULATIONS

12.1. ICV percent recoveries are calculated according to the equation:

$$\%R = 100\left(\frac{Found(ICV)}{True(ICV)}\right)$$

12.2. CCV percent recoveries are calculated according to the equation:

$$\%R = 100\left(\frac{Found(CCV)}{True(CCV)}\right)$$

12.3. Matrix Spike Recoveries are calculated according to the following equation:

$$\%\,R = 100\left(\frac{SSR - SR}{SA}\right)$$

Where:

SSR = Spike Sample Result
SR = Sample Result
SA = Spike Added

12.4. The relative percent difference (RPD) of matrix spike/matrix spike duplicates are calculated according to the following equations:

$$RPD = 100\left[\frac{|MSD - MS|}{\left(\frac{MSD + MS}{2}\right)}\right]$$

Where:

MS = determined spiked sample concentration
MSD = determined matrix spike duplicate concentration

12.5. The final concentration for a digested aqueous sample is calculated as follows:

$$mg / L = \frac{C \times V1 \times D}{V2}$$

Where:

C = Concentration (mg/L) from instrument readout
D = Instrument dilution factor
V1 = Final volume in liters after sample preparation
V2 = Initial volume of sample digested in liters

12.6. The final concentration determined in digested solid samples when reported on a dry weight basis is calculated as follows:

$$mg / Kg, dry\ weight = \frac{C \times V \times D}{W \times S}$$

Where:

C = Concentration (mg/L) from instrument readout
D = Instrument dilution factor
V = Final volume in liters after sample preparation
W = Weight in Kg of wet sample digested
S = Percent solids/100

Note: A Percent Solids determination must be performed on a separate aliquot when dry weight concentrations are to be reported. If the results are to be reported on wet weight basis the "S" factor should be omitted from the above equation.

12.7. The LCS percent recovery is calculated according to the following equation:

$$\%R = 100\left(\frac{Found(LCS)}{True(LCS)}\right)$$

12.8. The dilution test percent difference for each component is calculated as follows:

$$\%Difference = \frac{|I - S|}{I} \times 100$$

Where:
I = Sample result (Instrument reading)
S = Dilution test result (Instrument reading × 5)

12.9. Appropriate factors must be applied to sample values if dilutions are performed.

12.10. Sample results should be reported with up to three significant figures in accordance with the STL North Canton significant figure policy.

12.11. Trivalent Chromium

12.11.1. Trivalent chromium (CR^{+3}) is the result obtained by subtracting the hexavalent chromium (CR^{+6}) results for a sample from the total chromium result from that sample. The total chromium result is determined using the procedures in this SOP. The hexavalent chromium result is determined using the procedures in STL North Canton SOP NC-WC-0024.

12.11.2. Reporting Limits

12.11.2.1. The STL North Canton water reporting limit for trivalent chromium is 0.02 mg/l.

12.11.2.2. The STL North Canton solid reporting limit for trivalent chromium is 2.0 mg/kg, wet weight.

12.11.3. Calculations: Cr^{+3} = Cr, total – Cr^{+6}

13. METHOD PERFORMANCE

13.1. Each laboratory must have initial demonstration of performance data on file for each analyte of interest as described in Section 9.0.

13.2. Refer to Tables I, IA & II in Appendix A for the list of Method 6010B and 200.7 analytes as well as additional analytes that may be analyzed using this SOP.

13.3. Method performance is determined by the analysis of MS and MSD samples as well as method blanks and laboratory control samples. The MS or MSD recovery should fall within +/- 25 % and the MS/MSD should compare within 20% RPD or within the laboratory's historical acceptance limits. These criteria apply to analyte concentrations greater than or equal to 10xIDL. Method blanks must meet the criteria specified in Section 9.2. The laboratory control samples should recover within 20% of the true value or within the laboratory's historical acceptance limits.

13.4. Training Qualification:

13.4.1. The group/team leader or the supervisor has the responsibility to ensure that this procedure is performed by an associate who has been properly trained in its use and has the required experience.

14. POLLUTION PREVENTION

14.2. This method does not contain any specific modifications that serve to minimize or prevent pollution.

15. WASTE MANAGEMENT

15.1. This method does not contain any specific modifications that serve to minimize or prevent pollution.

15.2. All waste will be disposed of in accordance with Federal, State and Local regulations. Where reasonably feasible, technological changes have been implemented to minimize the potential for pollution of the environment. Employees will abide by this method and the policies in section 13 of the Corporate Safety Manual for "Waste Management and Pollution Prevention."

15.3. Waste Streams Produced by this Method

15.3.1 The following waste streams are produced when this method is carried out:

15.3.2 Acid waste consisting of sample and rinse solution - Any sample waste generated must be collected and disposed of in the acid waste drum located in the metals lab.

15.3.3 Standards should be purchased and prepared in volumes consistent with laboratory use to minimize the volume of expired standards to be disposed.

16. REFERENCES

16.1. References

16.1.1. 40 CFR Part 136, Appendix B, 7-5-95, Determination of Method Detection Limits.

16.1.2. Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, SW-846, 3rd Edition, Final Update III, Revision 2, December 1996. Method 6010B.

16.1.3. Determination of Metals and Trace Elements in Water and Wastes by Inductively Coupled Plasma-Atomic Emission Spectrometry, Revision 4.4, May 1994. Method 200.7.

16.1.4. Inductively Coupled Plasma – Atomic Emission Spectrometric Method for Trace Element Analysis of water and wastes Method 200.7, 40 CFR – Chapter I – Part 136 – Appendix C. Electronic version dated September 30, 2002.

16.1.5. CORP-MT-0002NC, Inductively Coupled Plasma-Atomic Emission Spectroscopy, Method 200.7 & CLP-M, SOW ILMO3.0 and ILMO4.0).

16.1.6. Corporate Quality Management Plan (QMP), current version

16.1.7. STL Laboratory Quality Manual (LQM), current version.

16.2. Associated SOPs and Policies, latest version

16.2.1. QA-003, STL North Canton QC Program.

16.2.2. Glassware Washing, NC-QA-0014

16.2.3. Statistical Evaluation of Data and Development of Control Charts, NC-QA-0018

16.2.4. Method Detection Limits and Instrument Detection Limits, NC-QA-0021

16.2.5. Navy/Army SOP, NC-QA-0016

16.2.6. QA-004, Rounding and Significant Figures.

16.2.7. NC-WC-0024, Hexavalent Chromium (Colorimetric)

16.2.8. CORP-IP-0002NC, Acid Digestion of Soils, SW846 Method 3050B

16.2.9. CORP-IP-0003NC, Acid Digestion of Aqueous Samples by SW846 and MCAWW 200 Series Methods

17. MISCELLANEOUS (TABLES, APPENDICES, ETC.)

17.1. Modifications/Interpretations from reference method

17.1.1. Modifications/interpretations from both Methods 6010B and 200.7.

17.1.1.1. STL North Canton laboratories use mixed calibration standard solutions purchased from approved vendors instead of using individual mixes prepared in house as recommended by the subject methods.

17.1.1.2. Methods 200.7 and 6010B state that if the correction routine is operating properly, the determined apparent analyte(s) concentration from analysis of each interference solution should fall within a specific concentration range around the calibration blank. In determining IECs, because of lack of definition clarification for "concentration range around the calibration blank," STL North Canton has adopted the procedure in EPA CLP ILMO4.0.

17.1.1.3. Section 8.5 of Method 6010B and Section 9.5 of Method 200.7 recommend that whenever a new or unusual matrix is encountered, a series of tests be performed prior to reporting concentration data for that analyte. The dilution test helps determine if a chemical or physical interference exists. Because STL North Canton laboratories receive no prior information from clients regarding when to expect a new or unusual matrix, STL North Canton may select to perform a dilution test on one sample in each prep batch. According to the method, the post digestion spike (PDS) determines any potential matrix interferences. At STL North Canton, matrix interference is determined by evaluating data for the LCS and MS/MSD. STL North Canton REQUIRES documented, clear guidance when a new or unusual matrix will be received for a project and a request to perform the dilution test or PDS on a client-identified sample.

17.1.2. Modifications from Method 200.7.

17.1.2.1. Method 200.7 defines the IDL as the concentration equivalent to a signal, due to the analyte, which is equal to three times the standard deviation of a series of ten replicate measurements of the calibration blank signal at the same wavelength. STL North Canton labs utilize the IDL definition as defined in Section 9.1 of this SOP.

17.1.2.2. The calibration blank is prepared in an acid matrix of 5% HNO_3/5% HCl instead of the specified 2% HNO_3/10% HCl matrix as the former matrix provides for improved performance relative to the wide variety of digestate acid matrices which result from the various EPA preparation protocols applied.

17.1.2.3. Method section 9.3.4 specifies that "Analysis of the IPC (ICSA/AB) solution immediately following calibration must verify that the instrument is within ± 5% of calibration with a relative standard deviation <3% from replicate integrations ≥ 4." STL North Canton uses a minimum of two exposures.

17.1.2.4. The 40 CFR version of Method 200.7 requires the instrument check standard to agree within ± 5% of expected values. Also, the 40 CFR version requires the interference check sample to be analyzed at the beginning, end, and at periodic intervals throughout the sample run. At STL North Canton, the instrument check standard equals the CCV, which must agree within ± 10% of expected values, and the ICSA standards are analyzed only at the beginning of a sample run. STL's procedures are in line with the Rev. 4.4, May 1994 version of Method 200.7.

17.1.2.5. Section 7.12 of 200.7 indicates that the QCS (ICV) should be prepared at a concentration near 1 ppm. The ICV specified in this SOP accommodates the 1 ppm criteria for the majority of analytes. For the remaining analytes, this SOP specifies ICV concentrations which are appropriate to the range of calibration. The intent of the ICV, verification of calibration standard accuracy, is independent of the ICV concentration used.

17.1.2.6. The ICS criteria applied by this SOP differ from those stated in the method. Method 200.7 section 10.4 states that results should fall within the established control limits of 3 times the standard deviation of the

calibration blank for that analyte. The control limits listed in this SOP are those applicable to the EPA designed solution.

17.1.2.7. Method 200.7 section 9.3.4 states the CCB should be less than the IDL, but > the lower 3-sigma control limit of the calibration blank. The intent of this requirement is to ensure that the calibration is not drifting at the low end. STL North Canton has adopted an absolute control limit of +/- RL from zero for calibration blank criteria. SOP section 9.7 provides the detailed corrective action criteria that must be followed.

17.1.3. Modifications from Method 6010B.

17.1.3.1. Chapter 1 of SW-846 states that the method blank should not contain any analyte of interest at or above the MDL. This SOP states that the method blank must not contain any analyte of interest at or above the reporting limit. Common lab contaminants are allowed up to two times the reporting limit in the blank following consultation with the client.

17.1.3.2. Method 6010B section 8.6.1.3 states that the results of the calibration blank are to agree within 3x the IDL. If not, repeat the analysis two or more times and average the results. If the average is not within three standard deviations of the background mean, terminate the analysis, correct the problem, recalibrate, and reanalyze the previous 10 samples. The intent of this requirement is to ensure that the calibration is not drifting at the low end. STL North Canton has adopted an absolute control limit of +/- RL from zero for calibration blank criteria. See SOP Section 9.7 for a detailed description of the required corrective action procedures.

APPENDIX A

TABLES

TABLE I. Method 200.7 and 6010B Target Analyte List

ELEMENT	Symbol	CAS #	6010B analyte	200.7 analyte	Reporting Limit (ug/L) Water	Reporting Limit (mg/kg) Soil
Aluminum	Al	7429-90-5	X	X	200	20
Antimony	Sb	7440-36-0	X	X	60	6
Arsenic	As	7440-38-2	X	X	300	30
Barium	Ba	7440-39-3	X	X	200	20
Beryllium	Be	7440-41-7	X	X	5.0	0.5
Boron	B	7440-42-8	X	X	200	20
Cadmium	Cd	7440-43-9	X	X	5.0	0.5
Calcium	Ca	7440-70-2	X	X	5000	500
Chromium	Cr	7440-47-3	X	X	10	1
Cobalt	Co	7440-48-4	X	X	50	5
Copper	Cu	7440-50-8	X	X	25	2.5
Iron	Fe	7439-89-6	X	X	100	10
Lead	Pb	7439-92-1	X	X	100	10
Magnesium	Mg	7439-95-4	X	X	5000	500
Manganese	Mn	7439-96-5	X	X	15	1.5
Molybdenum	Mo	7439-98-7	X	X	40	4
Nickel	Ni	7440-02-0	X	X	40	4
Potassium	K	7440-09-7	X	X	5000	500
Selenium	Se	7782-49-2	X	X	250	25
Silver	Ag	7440-22-4	X	X	10	1
Sodium	Na	7440-23-5	X	X	5000	500
Thallium	Tl	7440-28-0	X	X	2000	200
Vanadium	V	7440-62-2	X	X	50	5
Zinc	Zn	7440-66-6	X	X	20	2

TABLE IA. Method 200.7 and 6010B Trace ICP Target Analyte List

ELEMENT	Symbol	CAS #	Reporting Limit (ug/L) Water	Reporting Limit (mg/kg) Soil
Arsenic	As	7440-38-2	10	1.0
Lead	Pb	7439-92-1	3.0	0.3
Selenium	Se	7782-49-2	5.0	0.5
Thallium	Tl	7440-28-0	10	1.0
Antimony	Sb	7440-36-0	10	1.0
Cadmium	Cd	7440-43-9	2.0	0.2
Silver	Ag	7440-22-4	5.0	0.5
Chromium	Cr	7440-47-3	5.0	0.5

TABLE II. Non-Routine Analyte List

ELEMENT	Symbol	CAS #	Reporting Limit (ug/L) Water	Reporting Limit (mg/kg) Soil
Tin	Sn	7440-31-5	100	10
Titanium	Ti	7440-32-6	50	5

TABLE III. Matrix Spike and Aqueous Laboratory Control Sample Levels

ELEMENT	LCS Level (ug/L)	Matrix Spike Level (ug/L)
Aluminum	2000	2000
Antimony	500	500
Arsenic	2000	2000
Barium	2000	2000
Beryllium	50	50
Cadmium	50	50
Calcium	50000	50000
Chromium	200	200
Cobalt	500	500
Copper	250	250
Iron	1000	1000
Lead	500	500
Magnesium	50000	50000
Manganese	500	500
Molybdenum	1000	1000
Nickel	500	500
Potassium	50000	50000
Selenium	2000	2000
Silver	50	50
Sodium	50000	50000
Thallium	2000	2000
Vanadium	500	500
Zinc	500	500
Boron	1000	1000
Tin	2000	2000
Titanium	1000	1000

TABLE IV. ICP Calibration and Calibration Verification Standards

Element	Calibration Level	RL (ug/L)	ICV (ug/L)	CCV (ug/L)
Aluminum	100000	200	25000	50000
Antimony	10000	60	1000	5000
Arsenic	10000	300	1000	5000
Barium	10000	200	1000	5000
Beryllium	10000	5	1000	5000
Cadmium	10000	5	1000	5000
Calcium	100000	5000	25000	50000
Chromium	10000	10	1000	5000
Cobalt	10000	50	1000	5000
Copper	10000	25	1000	5000
Iron	100000	100	25000	50000
Lead	10000	100	1000	5000
Magnesium	100000	5000	25000	50000
Manganese	10000	15	1000	5000
Molybdenum	10000	40	1000	5000
Nickel	10000	40	1000	5000
Potassium	100000	5000	25000	50000
Selenium	10000	250	1000	5000
Silver	2000	10	500	1000
Sodium	100000	5000	25000	50000
Thallium	20000	2000	5000	10000
Vanadium	10000	50	1000	5000
Zinc	10000	20	1000	5000
Boron	10000	200	1000	5000
Tin	10000	100	1000	5000
Titanium	10000	50	1000	5000

TABLE IVA. Trace ICP Calibration and Calibration Verification Standards

Element	Calibration Level	RL (ug/L)	ICV (ug/L)	CCV (ug/L)
Aluminum	50000	200	12500	25000
Antimony	1000	10	250	500
Arsenic	1000	10	250	500
Barium	4000	10	1000	2000
Beryllium	4000	5	1000	2000
Cadmium	1000	2	250	500
Calcium	100000	5000	25000	50000
Chromium	4000	5	1000	2000
Cobalt	4000	50	1000	2000
Copper	4000	25	1000	2000
Iron	50000	100	12500	25000
Lead	1000	3	250	500
Magnesium	100000	5000	25000	50000
Manganese	4000	15	1000	2000
Molybdenum	4000	40	1000	2000
Nickel	4000	40	1000	2000
Potassium	100000	5000	25000	50000
Selenium	1000	5	250	500
Silver	2000	5	500	1000
Sodium	100000	5000	25000	50000
Thallium	2000	10	500	1000
Vanadium	4000	50	1000	2000
Zinc	4000	20	1000	2000

TABLE V. Interference Check Sample Concentrations*

Element	ICSA (ug/L)	ICSAB (ug/L)
Aluminum	500000	500000
Antimony	-	1000
Arsenic	-	1000
Barium	-	500
Beryllium	-	500
Cadmium	-	1000
Calcium	500000	500000
Chromium	-	500
Cobalt	-	500
Copper	-	500
Iron	200000	200000
Lead	-	1000
Magnesium	500000	500000
Manganese	-	500
Molybdenum	-	1000
Nickel	-	1000
Potassium	-	10000
Selenium	-	1000
Silver	-	1000
Sodium	-	10000
Thallium	-	10000**
Vanadium	-	500
Zinc	-	1000
Tin	-	1000
Boron		1000
Titanium		1000

* Custom STL North Canton solutions contain analytes common to all STL North Canton facilities. Non-routine elements not listed above should be spiked into the ICSAB at 1000 ug/L.

** Thallium level for Trace ICP should be at 1000 ug/L.

TABLE VI. TCLP Reporting Limits, Regulatory Limits and Matrix Spike Levels

ELEMENT	Reporting Level (ug/L)	Regulatory Limit (ug/L)	Spike Level (ug/L)
Arsenic	500	5000	5000
Barium	10000	100000	50000
Cadmium	100	1000	1000
Chromium	500	5000	5000
Lead	500	5000	5000
Selenium	250	1000	1000
Silver	500	5000	1000

TABLE VII. Summary Of Quality Control Requirements

QC PARAMETER	FREQUENCY *	ACCEPTANCE CRITERIA	CORRECTIVE ACTION
Two-point Initial Calibration	Beginning of every analytical run, every 24 hours, whenever instrument is modified, or CCV criterion is not met		Terminate analysis; Correct the problem; Prepare new standards; Recalibrate following system performance.
ICV	Beginning of every analytical run.	Method 200.7: 95 - 105 % recovery. RSD dupl. exp < 3% Method 6010B: 90 - 110 % recovery. RSD dupl. exp < 5%	Terminate analysis; Correct the problem; Recalibrate.
ICB	Beginning of every analytical run, immediately following the ICV.	The result must be within +/- RL from zero.	Terminate analysis; Correct the problem; Recalibrate.
CCV	Every 10 samples and at the end of the run.	Method 200.7 & 6010B: 90 - 110 % recovery. RSD dupl. exp < 5%	Terminate analysis; Correct the problem; Recalibrate and rerun all samples not bracketed by acceptable CCV.
CCB	Immediately following each CCV.	The result must be within +/- RL from zero.	Terminate analysis; Correct the problem; Recalibrate and rerun all samples not bracketed by acceptable CCB.
CRI	Beginning of every run	50-150% recovery (advisory)	Evaluate associated samples.
ICSA	Beginning of every run	See Section 9.8.3	See Section 9.8.3
ICSAB	Immediately following each ICSA.	Results must be within 80 - 120% recovery.	See Section 9.8.2.

* See Sections 11.10 and 11.13 for exact run sequence to be followed.

TABLE VII. Summary of Quality Control Requirements (Continued)

QC PARAMETER	FREQUENCY	ACCEPTANCE CRITERIA	CORRECTIVE ACTION
Dilution Test	One per prep batch.	For samples > 50x IDL, dilutions must agree within 10%.	Narrate the possibility of physical or chemical interference per client request.
Method Blank	One per sample preparation batch of up to 20 samples.	The result must be less than or equal to the RL. Common lab contaminants may be accepted up to 2x the RL (See 9.2). Sample results greater than 20x the blank concentration are acceptable. Samples for which the contaminant is < RL may not require redigestion or reanalysis (see Section 9.2).	Redigest and reanalyze samples. Note exceptions under criteria section. See Section 9.2 for additional requirements.
Laboratory Control Sample (LCS)	One per sample preparation batch of up to 20 samples.	Aqueous LCS must be within 80 - 120% recovery or in-house control limits. Samples for which the contaminant is < RL and the LCS results are > 120% may not require redigestion or reanalysis (see Section 9.3)	Terminate analysis; Correct the problem; Redigest and reanalyze all samples associated with the LCS.

TABLE VII. Summary of Quality Control Requirements (Continued)

QC PARAMETER	FREQUENCY	ACCEPTANCE CRITERIA	CORRECTIVE ACTION
Matrix Spike	One per sample preparation batch of up to 20 samples.	75 - 125 % recovery or in-house control limits. For TCLP See Section 11.17.	In the absence of client specific requirements, flag the data; no flag required if the sample level is > 4x the spike added. For TCLP see Section 11.17.
Matrix Spike Duplicate	See Matrix Spike	75 - 125 % recovery; RPD ≤ 20% .	See Corrective Action for Matrix Spike.

APPENDIX B

CROSS REFERENCE OF TERMS USED IN METHODS 6010B, 200.7, AND BY STL NORTH CANTON

CROSS REFERENCE OF TERMS COMMONLY USED IN METHODS EPA 200.7, SW6010B, AND STL NORTH CANTON INC. SOP

EPA 200.7	SW6010B	STL North Canton Inc. SOP
Calibration blank (CB)	Calibration blank	Initial and continuing calibration blanks (ICB/CCB)
Dilution test	Dilution test	Dilution Test
Instrument detection limit (IDL)	Instrument detection limit (IDL)	Instrument detection limit (IDL)
Instrument performance check (IPC)	Continuing calibration verification (CCV)	Continuing calibration verification (CCV)
Internal standard	Internal standard	Internal standard (IS)
Laboratory duplicates	n/a	n/a
Laboratory fortified blank (LFB)	n/a	Laboratory control sample (LCS)
Laboratory fortified sample matrix (LFM)	Matrix spike and matrix spike duplicate (MS/MSD)	Matrix spike and matrix spike duplicate (MS/MSD)
Laboratory reagent blank (LRB)	Method blank	Method or Prep blank (MB)
Linear dynamic range (LDR)	Linear dynamic range (LDR)	Linear dynamic range (LDR)
Method detection limit (MDL)	Method detection limit (MDL)	Method detection limit (MDL)
Quality control sample (QCS)	Check standard or Initial calibration verification (ICV)	Initial calibration verification (ICV)
Spectral interference check solution (SIC)	Interference check solution (ICS)	Interference check solution (ICSA/ICSAB)

APPENDIX C

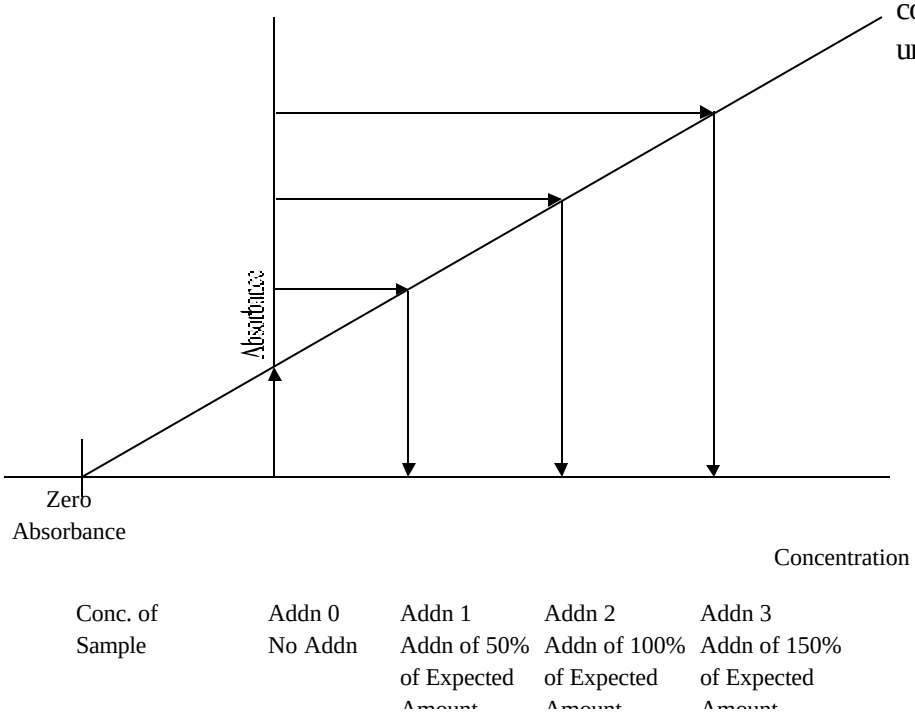
MSA GUIDANCE

Appendix C. MSA Guidance

Method of Standard Addition

Four equal volume aliquots of sample are measured and known amounts of standards are added to three aliquots. The fourth aliquot is the unknown and no standard is added to it. The concentration of standard added to the first aliquot should be 50% of the expected concentration. The concentration of standard added to the second aliquot should be 100% of the expected concentration and the concentration of standard added to the third aliquot should be 150% of the expected concentration. The volume of the unspiked and spiked standard should be the same.

In order to determine the concentration of analyte in the sample, the analytical value of each solution is determined and a plot or linear regression performed. On the vertical axis the analytical value is plotted versus the concentrations of the standards on the horizontal axis. An example plot is shown in Figure 1. When the resulting line is extrapolated back to zero absorbance, the point of interception of the horizontal axis is the concentration of the unknown.



For the method of standard additions to be correctly applied, the following limitations must be taken into consideration:

- The plot of the sample and standards must be linear over the concentration range of concern. For best results, the slope of the curve should be similar to that of a plot of the aqueous standard curve.

- The effect of the interference should not vary as the ratio of the standard added to the sample matrix changes.

APPENDIX D

TROUBLESHOOTING GUIDE

APPENDIX D. TROUBLESHOOTING GUIDE

Problem	**Possible Cause/ Solution**
High Blanks	Increase rinse time Clean or replace tip Clean or replace torch Clean or replace sample tubing Clean or replace nebulizer Clean or replace mixing chamber Lower Torch
Instrument Drift	RF not cooling properly Vacuum level is too low Replace torch (Crack) Clean or replace nebulizer (blockage) Check room temperature (changing) Replace pump tubing Room humidity too high Clean torch tip (salt buildup) Check for argon leaks Adjust sample carrier gas Reprofile Horizontal Mirror Replace PA tube
Erratic Readings, Flickering Torch or High RSD	Check for argon leaks Adjust sample carrier gas Replace tubing (clogged) Check drainage(back pressure changing) Increase uptake time (too short) Increase flush time (too short) Clean nebulizer, torch or spray chamber Increase sample volume introduced Check that autosampler tubes are full Sample or dilution of sample not mixed Increase integration time (too short) Realign torch Reduce amount of tubing connectors
Cu/Mn Ratio Outside Limits or Low Sensitivity	Plasma conditions changed Clean nebulizer, torch or spray chamber Replace tubing (clogged) Realign torch Check IECs
Standards reading twice normal absorbance or concentration	Incorrect standard used Incorrect dilution performed

APPENDIX E

CONTAMINATION CONTROL GUIDELINES

APPENDIX E. CONTAMINATION CONTROL GUIDELINES

The following procedures are strongly recommended to prevent contamination:

All work areas used to prepare standards and spikes should be cleaned before and after each use.

All glassware should be washed with detergent and tap water and rinsed with 1:1 nitric acid followed by deionized water.

Proper laboratory housekeeping is essential in the reduction of contamination in the metals laboratory. All work areas must be kept scrupulously clean.

Powdered or Latex Gloves must not be used in the metals laboratory since the powder contains silica and zinc as well as other metallic analytes. Only vinyl or nitrile gloves should be used in the metals laboratory.

Glassware should be periodically checked for cracks and etches and discarded if found. Etched glassware can cause cross contamination of any metallic analytes.

Autosampler trays should be covered to reduce the possibility of contamination. Trace levels of elements being analyzed in the samples can be easily contaminated by dust particles in the laboratory.

The following are helpful hints in the identification of the source of contaminants:

Yellow pipet tips and volumetric caps can sometimes contain cadmium.

Some sample cups have been found to contain lead.

The markings on glass beakers have been found to contain lead. If acid baths are in use for glassware cleaning, they should be periodically checked for contaminants since contaminant concentrations will increase over time.

New glassware especially beakers can be a source of silica and boron.

Reagents or standards can contain contaminants or be contaminated with the improper use of a pipette.

Improper cleaning of glassware can cause contamination.

Latex gloves contain over 500 ppb of zinc.

APPENDIX F

PREVENTIVE MAINTENANCE

APPENDIX F. PREVENTIVE MAINTENANCE

A maintenance log is used to record when maintenance is performed on instruments. When an instrument problem occurs indicate the date, time and instrument number, then identify the problem and corrective action in the maintenance log.

The following procedures are required to ensure that that the instrument is fully operational.

Daily
Change sample pump tubing and pump windings
Check argon gas supply level
Check rinse solution and fill if needed
Check waste containers and empty if needed
Check sample capillary tubing is clean and in good condition
Check droplet size to verify nebulizer is not clogged.
Check sample flow for cross flow nebulizer
Check Cu/Mn ratio-should be 30% of value at date that IECs were performed
Check pressure for vacuum systems

As Needed
Clean plasma torch assembly to remove accumulated deposits
Clean nebulizer and drain chamber; keep free-flowing to maintain optimum performance
Replace peristaltic pump tubing, sample capillary tubing and autosampler sipper probe

Weekly
Apply silicon spray on autosampler tracks
Check water level in coolflow

Monthly
Clean air filters on back of power unit to remove dust
Check D mirror for air instruments

Bi-yearly
Change oil for vacuum systems
Replace coolant water filter (may require more or less frequently depending on quality of cooling water)

APPENDIX G

ICP OPERATING INSTRUCTIONS

ICP Analysis (TJA 61E)

(Example)

1. SETUP

a. Plasma Control Panel (enter)

b. (F1)-Startup

c. (F9)-Continue

d. (F2)-Levels

1. Change auxiliary gas to low – use space bar to toggle
2. Change nebulizer gas flow to 0.5 L/min.
3. Change pump rate to 130
4. Esc
5. Allow instrument to warm up approximately 30 minutes.

2. DEVELOPMENT

a. Methods (enter)

b. Enter method name

c. (F3)-Method Info.

d. Change file name

e. (F9)-Done

f. (F9)-Done/Keep

18. OPERATION

a. Analysis (enter)

b. (F5)-Profile

1. (F3)-Automatic

2. (F1)-Run

3. If peak position is greater than +/- .05 units from the center peak position, you must adjust the profile. If it is within +/- .05 units, press (F9)-done.

4. To adjust select (F1)-CalcSS and enter current vernier position. (enter)

5. Adjust to new vernier position(F9)-done

6. Rerun profile until peak position is +/- .05 units.

7. (F9)-Done

c. Autosampler (F9)

1. Enter method name (enter)

2. Enter autosampler table name (enter)

3. (F1)-Run

STL NORTH CANTON STANDARD OPERATING PROCEDURE

TITLE: **EXTRACTION AND CLEANUP OF ORGANIC COMPOUNDS FROM WATERS AND SOILS, BASED ON SW-846 3500 SERIES, 3600 SERIES, 8151A AND 600 SERIES METHODS.**

(SUPERSEDES: Revision 4.0 (Dated 02/04/03)

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Appendix A Extraction Procedure for Chlorinated Acid Herbicides Based on Method 8151A 55

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Table A4 Herbicide matrix spike and LCS components

1. SCOPE AND APPLICATION

This SOP describes procedures for preparation (extraction and cleanup) of semivolatile organic analytes in aqueous, TCLP leachate, and soil matrices for analysis by Gas Chromatography (GC) and Gas Chromatography / Mass Spectrometry (GC/MS). The procedures are based on SW-846 and 600 series methodology and are applicable for measurements made to comply with the Resource Conservation and Recovery Act (RCRA) and for wastewater testing.

1.1. Extraction procedures for the following determinative methods are covered: 8081A, 8082, 8141A, 8151B, 8270C, 8310, 8015B, 8100, 608, 610, and 625

1.2. The extraction procedures here may be appropriate for other determinative methods when appropriate spiking mixtures are used.

1.3. Other extraction procedures (PFE, SPE, accelerated Soxhlet, etc.) may be used but are not currently covered in this SOP.

1.4. The applicable LIMS method codes are: P2 (8141A), QJ (8081A), QS (8151A), QL (8270C), SG (8310), DM (608), VT (610), DP (625), A1 (8100), HS (8015B)

2. SUMMARY OF METHOD

2.1. Separatory Funnel Extraction

A measured volume of sample, typically 1 liter, is adjusted, if necessary, to a specified pH and serially extracted with methylene chloride using a separatory funnel.

2.2. Continuous Liquid/Liquid Extraction

A measured volume of sample, typically 1 liter, is placed into a continuous liquid/liquid extractor, adjusted, if necessary, to a specific pH and extracted with methylene chloride for 18-24 hours.

2.3. Sonication Extraction

A measured weight of sample, typically 30 g, is mixed with anhydrous sodium sulfate to form a free flowing powder. This is solvent extracted three times using an ultrasonic horn.

2.4. Soxhlet Extraction (Accelerated and Traditional)

A 30 g sample is mixed with anhydrous sodium sulfate to form a free flowing powder. This is extracted with refluxing solvent.

2.5. Cleanup and Concentration

Procedures are presented for removing interferents from sample extracts, and for drying and concentration of the extract to final volume for analysis.

2.6. Phenoxy acid herbicide extractions

Procedures for the extraction and cleanup of phenoxy acid herbicides are presented in Appendix A.

3. DEFINITIONS

Definitions of terms used in this SOP may be found in the glossary of the STL North Canton Laboratory Quality Manual (LQM), current version .

4. INTERFERENCES

4.1. Method interferences may be caused by contaminants in solvents, reagents, glassware, and other processing apparatus. All these materials must be routinely demonstrated to be free from interferences under conditions of the analysis by running laboratory method blanks as described in the Quality Control section. Specific selection of reagents may be required to avoid introduction of contaminants.

4.2. Visual interferences or anomalies (such as foaming, emulsions, odor, etc.) must be documented.

5. SAFETY

5.1. Employees must abide by the policies and procedures in the Corporate Safety Manual, Radiation Safety Manual, Lab Specific Addendum to the CSM, and this document.

5.2. Eye protection that protects against splash, laboratory coat and appropriate gloves must be worn while samples, standards, solvents and reagents are being handled. Disposable gloves that have become contaminated will be removed and discarded, other gloves will be cleaned immediately. Viton gloves may be worn when halogenated solvents are used for extractions or sample preparation. Nitrile gloves may be used when other solvents are handled. [Note: VITON is readily degraded by acetone]. When good manual dexterity is needed, for example, when handling small quantities/containers, disposable gloves (such as latex or N-DEX®) shall be used. While these gloves protect against splashes, they give little or no protection against contact with large quantities of solvent, and no protection against spills or immersion.

5.3. The following analytes have been tentatively classified as known or suspected, human or mammalian carcinogens: benzo(a)anthracene, benzidine, 3,3'dichlorobenzindine, benzo(a)pyrene, alpha-BHC, beta-BHC, gamma-BHC,

delta-BHC, dibenz(a,h)anthracene, N-nitrosodimethylamine, 4,4'-DDT, and polychlorinated biphenyl compounds. Primary standards of these toxic compounds should be prepared in hood.

5.4. The following is a list of the materials used in this method, which have a serious or significant hazard rating. NOTE: This list does not include all materials used in the method. The table contains a summary of the primary hazards listed in the MSDS for each of the materials listed in the table. A complete list of materials used in the method can be found in the reagents and materials section. Employees must review the information in the MSDS for each material before using it for the first time or when there are major changes to the MSDS.

Material (1)	Hazards	Exposure Limit (2)	Signs and symptoms of exposure
Methylene Chloride	Carcinogen Irritant	25 ppm-TWA 125 ppm-STEL	Causes irritation to respiratory tract. Has a strong narcotic effect with symptoms of mental confusion, light-headedness, fatigue, nausea, vomiting and headache. Causes irritation, redness and pain to the skin and eyes. Prolonged contact can cause burns. Liquid degreases the skin. May be absorbed through skin.
Sodium Hydroxide	Corrosive Poison	2 ppm, 5 mg/m^3 2 Mg/M3-Ceiling	This material will cause burns if comes into contact with the skin or eyes. Severe irritant. Effects from inhalation of dust or mist vary from mild irritation to serious damage of the upper respiratory tract, depending on severity of exposure. Symptoms may include sneezing, sore throat or runny nose. Contact with skin can cause irritation or severe burns and scarring with greater exposures. Causes irritation of eyes, and with greater exposures it can cause burns that may result in permanent impairment of vision, even blindness.
Sulfuric Acid (1)	Corrosive Oxidizer Dehydrator Poison Carcinogen	1 mg/m^3	This material will cause burns if comes into contact with the skin or eyes. Inhalation of vapors will cause irritation of the nasal and respiratory system. Symptoms may include irritation of the nose and throat, and labored breathing. Symptoms of redness, pain, and severe burn can occur. Contact can cause blurred vision, redness, pain, and severe tissue burns. Can cause blindness.

Acetone	Flammable	1000 ppm-TWA	Inhalation of vapors irritates the respiratory tract. May cause coughing, dizziness, dullness, and headache.
Acetonitrile	Flammable Poison	40 ppm-TWA	Early symptoms may include nose and throat irritation, flushing of the face, and chest tightness. Prolonged exposure to high levels of vapors may cause formation of cyanide anions in the body.
Hexane	Flammable Irritant	500 ppm-TWA	Inhalation of vapors irritates the respiratory tract. Overexposure may cause lightheadedness, nausea, headache, and blurred vision. Vapors may cause irritation to the skin and eyes.
1 – Always add acid to water to prevent violent reactions.			
2 – Exposure limit refers to the OSHA regulatory exposure limit.			

5.5. Exposure to hazardous chemicals must be maintained **as low as reasonably achievable**, therefore, unless they are known to be non-hazardous, all samples should be opened, transferred and prepared in a fume hood, or under other means of mechanical ventilation. Solvent and waste containers will be kept closed unless transfers are being made.

5.6. The preparation of standards and reagents and glassware cleaning procedures that involve solvents such as methylene chloride will be conducted in a fume hood with the sash closed as far as the operations will permit. Use of methylene chloride for glassware cleaning should be avoided as far as possible. If more than 500 mL of Methylene chloride is spilled, evacuate the area until the area has been cleaned by EH&S.

5.7. All work must be stopped in the event of a known or potential compromise to the health and safety of a STL North Canton associate. The situation must be reported **immediately** to a laboratory supervisor.

5.8. During Kuderna-Danish (KD) concentration, do not allow the extract to boil to dryness. The solvent vapors remaining in the KD apparatus may superheat and create an explosion or fire hazard. The KD apparatus and glass separatory funnels have ground glass joints which can become stuck. Technicians must use Kevlar or other cut/puncture resistant gloves when separating stuck joints.

5.9. 3510 Separatory Funnel

5.9.1. The use of separatory funnels to extract aqueous samples with Methylene Chloride creates excessive pressure very rapidly. Initial venting should be done immediately after the sample container has been sealed and inverted, periodic venting may be necessary during the extraction. Vent the funnel into the hood away from people and other samples. This is considered a high-risk activity, the use of a face shield over safety glasses or goggles is recommended. Keep the sash on the fume hood as low as reasonably possible.

5.10. 3520 Extraction Cont Liq/Liq

5.10.1. All personnel are to ensure liquid-liquid area is clear of unnecessary items. Heating mantles used with liquid- liquid extractions generate temperatures that could ignite some materials that come in contact with the heating mantles.

5.10.2. Ensure all solvents are away from liquid-liquid extractor. Increased temperatures near solvents can cause the pressure in the containers to increase.

5.10.3. Ensure all boiling flasks have cooled to room temperature before disconnecting liquid-liquid bodies from boiling flasks to prevent any burns.

6. EQUIPMENT AND SUPPLIES

6.1. Glassware should be cleaned with soap and water, rinsed with water and dried in an oven at 400°C for at least 2 hours. Alternatively the glassware can be solvent rinsed with acetone or methanol followed by methylene chloride after the water rinse.

6.2. Equipment and supplies for extraction procedures

EQUIPMENT AND SUPPLIES	Sep fun.	CLLE	Soni	Sox	Conc
Separatory Funnel: 2 L	√				
Separatory Funnel Rack	√				
Balance: >1400 g capacity, accurate ±1 g	√	√			
pH indicator paper, wide-range: covers extraction pH	√	√			
Graduated cylinder: 1 liter. (other sizes may be used)	√	√			
Erlenmeyer Flask or Fleaker: 125 & 300 mL (other sizes optional)	√		√		
Centrifuge	√				
Auto-Shaker	√				

EQUIPMENT AND SUPPLIES	Sep fun.	CLLE	Soni	Sox	Conc
Methylene Chloride Collection Tank	√	√			
Solvent Dispenser Pump or 100 mL Graduated Cylinder	√		√		
Continuous Liquid/Liquid Extractor		√			
Round or flat Bottom: 250, 500 mL or 1 L		√			
Boiling Chips: Contaminant free, approximately 10/40 mesh (Teflon® PTFE, carbide or equivalent).		√		√	√
Cooling Condensers		√		√	
Heating Mantle: Rheostat controlled		√		√	
Auto-timer for heating mantle		√		√	
Beakers: 250 & 400 mL, graduated			√		
450mL wide-mouth glass jars			√		
Balance: >100 g capacity, accurate ±0.1 g			√	√	
Soxhlet Extractor				√	
Cellulose and Glass Thimbles				√	
Accelerated Soxhlet Extractor (Soxtherm-trade name)				√	
Sonicator (at least 300 watts)			√		
Sonicator horn, 3/4 inch			√		
Kuderna-Danish (K-D) Apparatus: 500 mL					√
Concentrator Tube: 10 mL, attached to K-D with clips					√
Snyder Column: Three-ball macro					√
Water Bath: Heated, with concentric ring cover, capable of temperature control (± 5°C) up to 95°C. The bath must be used in a hood or with a solvent recovery system.					√
Turbo Vap II					√
Turbo Vap Tube: 200mL capacity					√
Vials: Glass, 2 mL, 4 mL, and 10 mL capacity with Teflon®-lined screw-cap					√
Nitrogen Blowdown Apparatus					√
Nitrogen: reagent grade.					√
Culture tubes: 10 mL, 16 mmx100 mm					√
Syringe: 1 mL	√	√	√	√	
Phase Separation Paper	√	√	√	√	
Glass Wool	√	√	√	√	
Glass Funnel: 75 X 75 mm	√	√	√	√	√
Disposable Pipets	√	√	√	√	√
Aluminum foil	√	√	√	√	√
Paper Towels	√	√	√	√	√
Wrist Shaker					

6.3. Equipment and Supplies for Cleanup Procedures

EQUIPMENT AND SUPPLIES	GPC	Florisil	Sulfur	Acid	A/B	*FC*
Gel permeation chromatography system (J2 Scientific Accuprep System)	√					
Bio Beads: (S-X3) -200-400 mesh, 70 gm (Bio-Rad Laboratories, Richmond, CA, Catalog 152-2750 or equivalent).	√					
Chromatographic column: 700 mm x 25 mm ID glass column. Flow is upward.	√					
Ultraviolet detector: Fixed wavelength (254 nm) and a semi-prep flow-through cell.	√					
Strip chart recorder, recording integrator, or laboratory data system.	√					
Syringe: 10 mL with Luerlok fitting.	√					
Syringe filter assembly, with disposable 5 um filter discs, Millipore No. LSWP 01300 or equivalent.	√					
Chromatographic column: 250 mm long x 10 mm ID; with Pyrex glass wool at the bottom and a Teflon stopcock (for silica gel cleanup).	√					
Vacuum system for eluting multiple cleanup cartridges. Supelco (or equivalent). The manifold design must ensure that there is no contact between plastics containing phthalates and sample extracts.		√				
Vacuum trap made from a 500 mL sidearm flask fitted with a one-hole stopper and glass tubing.		√				
Vacuum pressure gauge.		√				
Rack for holding 10 mL volumetric flasks in the manifold.		√				
Mechanical shaker or mixer: Vortex Genie or equivalent.			√	√		
Separatory Funnels with Ground-Glass Stoppers: 250 mL					√	
Erlenmeyer Flasks: 125 mL					√	
Disposable Pipets		√	√	√	√	√
Culture tubes: 10 mL, 16 mmx100 mm	√	√	√	√	√	√

7. REAGENTS AND STANDARDS

7.1. Reagents for Extraction Procedures

All reagents must be ACS reagent grade or better unless otherwise specified.

REAGENTS	Sep fun.	CLLE	Soni	Sox	Conc
Sodium hydroxide (NaOH), Pellets: Reagent Grade	√	√			
Sodium hydroxide solution, 10 N: Dissolve 40 g of NaOH in reagent water and dilute to 100 mL.	√	√			
Sulfuric acid (H_2SO_4), Concentrated: Reagent Grade	√	√			
Sulfuric acid (1:1): Carefully add 500 mL of H_2SO_4 to 500 mL of reagent water. Mix well.	√	√			

REAGENTS	Sep fun.	CLLE	Soni	Sox	Conc
Hydrochloric Acid (HCl)					
Organic free reagent water.	√	√			
Sodium sulfate (Na_2SO_4), Granular, Anhydrous: Purify by heating at 400°C a minimum of two hours.	√	√	√	√	√
Extraction/Exchange Solvents: Methylene chloride, hexane, acetonitrile, acetone, pesticide quality or equivalent	√	√	√	√	√
Acetone: Used for cleaning	√	√	√	√	√

7.2. Reagents for Cleanup Procedures

REAGENTS	GPC	Florisil	Sulfur	Acid	A/B	*FC*
Florisil: 500 mg or 1 g cartridges with stainless steel or Teflon frits (calalog 694-313, Analytichem, 24201 Frampton Ave., Harbor City, CA, or equivalent.)		√				
Mercury: triple distilled			√			
Tetrabutylammonium hydrogen sulfate			√			
Sodium sulfite			√			
Tetrabutylammonium (TBA) sulfite reagent: Prepare reagent by dissolving 3.39 g of Tetrabutylammonium hydrogen sulfate in 100 mL organic-free reagent water. Extract this solution 3 times with 20 mL portions of hexane. Discard the hexane extracts. Add 25 g sodium sulfite to the water solution.			√			
2-Propanol			√			
Nitric acid: 1N			√			
Copper powder: remove oxides (if powder is dark) by treating with 1N nitric acid, rinse with organic-free reagent water to remove all traces of acid, rinse with acetone, and dry under a stream of nitrogen.			√			
Sulfuric acid, Concentrated				√		
Sodium hydroxide, Pellets					√	
Sodium hydroxide, 10N: Dissolve 40 g of NaOH in 100 mL of reagent water					√	
Sulfuric acid (H_2SO_4), Concentrated: Reagent Grade					√	
Sulfuric acid (1:1): Carefully add 500 mL of H_2SO_4 to 500 mL of reagent water. Mix well.					√	
Fluorocarbon: PF-5080, 3M						√

7.3. Standards

7.3.1. Stock Standards

Stock standards are purchased as certified solutions or prepared from neats. Semivolatile stock standards are stored at $\leq 6^{o}C$. All stock standards must be protected from light. Stock standard solutions must be replaced after one year (from the time of preparation, if prepared in house, or from the

time the ampoule is opened if purchased.) Standards must be allowed to come to room temperature before use.

7.3.2. Surrogate Spiking Standards

Prepare or purchase surrogate spiking standards at the concentrations listed in Table 5. Surrogate spiking standards are purchased or prepared as dilutions of the stock standards. Surrogate spiking solutions must be refrigerated and protected from light. The standards must be replaced at least every six months or sooner if there is reason to believe that the standard has degraded or concentrated.

7.3.3. Matrix Spiking and Laboratory Control Spiking Standards.

The same spiking solution is used for the matrix spike and the Laboratory Control Sample. Prepare MS/LCS spiking standards at the concentrations listed in Table 6. Spiking standards are purchased or prepared as dilutions of the stock standards. Spiking solutions must be refrigerated and protected from light. The standards must be replaced at least every six months or sooner if there is reason to believe that the standard has degraded or concentrated.

7.3.4. GPC calibration solution - prepare or purchase a solution in methylene chloride that contains the following analytes in the concentrations listed below:

Analyte	mg/mL
Corn Oil	25.0
Bis (2-ethylhexyl) phthalate	1.0
Methoxychlor	0.2
Perylene	0.02
Sulfur	0.08

NOTE: Sulfur is not very soluble in methylene chloride, however, it is soluble in warm corn oil. Therefore, one approach is to weigh out the corn oil, warm it, and transfer the weighed amount of sulfur into the warm corn oil. Mix it and then transfer into a volumetric flask with methylene chloride, along with the other calibration compounds. This standard has a lifetime of 6 months.

8. SAMPLE COLLECTION PRESERVATION AND STORAGE

8.1. Samples are not chemically preserved.

8.2. Samples are stored at 4°C ± 2°C in glass containers with Teflon®-lined caps.

8.3. Holding Times

8.3.1 Extraction is initiated within 7 days of the sampling date for aqueous samples, 14 days for solid and waste samples.

8.3.2 For TCLP leachates, extraction is initiated within seven days from when the TCLP Leach tumbling has been completed, excluding the filtration step. If the filtration step requires extended times, this time counts as part of the seven day holding time.

8.3.3. Analysis of the extracts is completed within forty days of extraction.

9. QUALITY CONTROL

9.1. Quality Control Batch

9.1.1. The batch is a set of up to 20 samples that are of the same matrix and are processed together using the same procedures and reagents. The batch must contain a method blank, an LCS and a matrix spike / matrix spike duplicate. (In some cases, at client request, it may be appropriate to process a matrix spike and sample duplicate in place of the MS / MSD). If clients specify specific samples for MS/MSD, the batch may contain multiple MS/MSD. See policy QA-003 for further definition of the batch.

9.2. Definition of matrix

9.2.1. The possible matrix types are aqueous, soil, waste and TCLP leachate.

9.3. Insufficient Sample

9.3.1. If insufficient sample is available to process a MS/MSD, then a second LCS must be processed. The LCS pair is then evaluated according to the MS/MSD criteria. Use of a LCS pair in place of a MS/MSD must be documented.

9.4. Sample count

9.4.1. Laboratory generated QC samples (method blanks, LCS, MS/MSD) are not included in the sample count. Field samples are included.

9.5. Method Blank

9.5.1. A method blank consisting of all reagents added to the samples must be prepared and analyzed with each batch of samples. Surrogates are spiked into the method blank at the same level as the samples. The method blank is used to identify any background interference or contamination of the analytical system which may lead to the reporting of elevated concentration levels or false positive data.

9.5.2. Aqueous Method Blanks use 1000 mL of reagent water spiked with the surrogates. The method blank goes through the entire analytical procedure, including any cleanup steps.

9.5.3. Solid method blanks use 30 g of sodium sulfate spiked with the surrogates. The method blank goes through the entire analytical procedure, including any cleanup steps.

9.5.4. TCLP method blanks use 250 mL of leachate fluid (100 mL for herbicides) spiked with the surrogates. The leachate may optionally be diluted to 1000 mL with reagent water. The method blank goes through the entire analytical procedure, including any cleanup steps.

9.6. Laboratory Control Sample (LCS)

9.6.1. Laboratory Control Samples are well-characterized, laboratory generated samples used to monitor the laboratory's day to day performance of routine analytical methods. The LCS, spiked with a group of target compounds representative of the method analytes, is used to monitor the accuracy of the analytical process, independent of matrix effects. On-going monitoring of the LCS results provides evidence that the laboratory is performing the method within accepted QC guidelines for accuracy and precision. The LCS goes through the entire analytical procedure, including any cleanup steps.

9.6.2. The LCS is made up in the same way as the method blank (See sections 9.5.1 - 9.5.4) but spiked with the LCS standard and the surrogates.

9.7. Surrogates

9.7.1. Surrogates are organic compounds which are similar to the target analyte(s) in chemical composition and behavior in the analytical process, but which are not normally found in environmental samples.

9.7.2. Each applicable sample, blank, LCS and MS/MSD is spiked with surrogate standards. Surrogate spike recoveries must be evaluated by determining

whether the concentration (measured as percent recovery) falls within the required recovery limits.

9.7. Matrix Spike/Matrix Spike Duplicate (MS/MSD)

9.7.1. A matrix spike is an environmental sample to which known concentrations of target analytes have been added. A matrix spike duplicate is a second spiked aliquot of the same sample which is prepared and analyzed along with the sample and matrix spike.

9.8. Initial Demonstration of Capability

9.8.1. The initial demonstration and method detection limit studies described in section 13 must be acceptable before analysis of samples may begin.

9.9. Quality Assurance Summaries

9.9.1. Certain clients may require specific project or program QC which may supersede these method requirements. Quality Assurance Summaries (QAS) should be developed to address these requirements.

9.10. STL North Canton QC Program

9.10.1. Further details of QC and corrective action guidelines are presented in the STL North Canton QC Program document (QA-003). Refer to this document if in doubt regarding corrective actions.

10. CALIBRATION AND STANDARDIZATION

10.1. On a weekly basis, measure 1.0 mL of solvent into an autovial using a gastight syringe that is manufactured to a certified volume delivery tolerance of ±0.01 mL (1mL total volume). The "standard" autovial is sealed and the top and bottom of the meniscus are marked. The autovials containing the sample extracts are then compared against the "standard" vial to ensure that the final volume is consistently 1.0 ± 0.01 mL. If a new box of autovials are used, then the steps are repeated to further ensure that variations due to vial size and shape are minimized. A log is kept of the lot number of the vials and the day the vials were prepared.

10.2. Refer to section 11.15. for calibration of the GPC. Otherwise this section is not applicable.

11. PROCEDURE

Procedures for separatory funnel liquid/liquid extraction (11.2), continuous liquid/liquid extraction (11.4), sonication extraction (11.5), soxhlet extraction (11.6), accelerated soxhlet (11.7), waste dilution (11.8), extract concentration (11.9), and extract cleanup (11.19) are presented in this section.

11.1. Procedural Variations

Procedural variations are allowed only if deemed necessary in the professional judgment of the supervisor to accommodate variation in sample matrix, radioactivity, chemistry, sample size, or other parameters. Any variation in procedure shall be completely documented using a Nonconformance memo and approved by a supervisor and QA/QC manager. If contractually required, the client will be notified. The Nonconformance memo will be filed in the project file.

Any deviations from this procedure identified after the work has been completed must be documented as a nonconformance, with a cause and corrective action described. A Nonconformance memo shall be used for this documentation.

11.2. Separatory Funnel Liquid/Liquid Extraction of Water Samples.

A flow chart for this procedure is included in Section 17.

11.2.1. Measure the initial sample pH with wide-range pH paper and record on the extraction benchsheet. If sample is a leachate (e.g. TCLP), compare the current pH against leachate log, note on the benchsheet if there is any discrepancy.

11.2.2. The normal sample volume is 1 liter. Other sample volumes may be used to obtain specific reporting limits, and reduced sample volumes, diluted to 1 liter with reagent water, may be used for very dirty samples.

11.2.3. Weigh the sample container on a balance (± 1 g), taring the sample and container. Transfer the sample to the separatory funnel. . Add the appropriate volume of surrogate spiking solution (see Table 3). Also add appropriate volume of matrix spiking solution to any matrix spike / matrix spike duplicate samples (see.Table 4) Mix well. Rinse the sample bottle with 60 mL methylene chloride and transfer to the separatory funnel. Reweigh the container. Assume a density of 1 g/mL and record the difference as the sample volume on the benchsheet to the nearest milliliter.

Note: Aqueous samples must be determined volumetrically for Ohio VAP samples.

Warning: Dichloromethane creates excessive pressure very rapidly! Therefore, initial venting should be done immediately after the sample container has been sealed and inverted. Vent into hood away from analysts and other samples.

11.2.3.1. If the entire sample bottle will not be used, transfer the aliquot to the separatory funnel, then add the spiking solutions to the sample in the separatory funnel.

Note: Alternative methods of measurement of sample volume include a) transferring the sample to a measuring cylinder and b) marking a meniscus on the sample bottle and then measuring the volume of water required to fill the bottle to the meniscus after the sample is transferred. The former method is not recommended because of the risk of cross contamination while the latter is not recommended because of poor accuracy. However, either method may be necessary for specific client programs.

11.2.4. Prepare a method blank, LCS and MS/MSD for each batch as specified in section 9 of this SOP. Use 1 L of reagent water for method blanks and LCS. The LCS is spiked with the surrogate and matrix spike solutions, the method blank only with the surrogates.

11.2.5. Use 250 mL of leachate for TCLP pesticides and TCLP semivolatiles, measured in a graduated cylinder. An alternative method would be to tare 400ml beaker on the balance and then add 250g to the beaker. Assume a density of 1g/mL and record the volume on the benchsheet. The leachate may be made up to 1 L in volume with reagent water.

11.2.6. For a TCLP method blank, LCS and LCS Dup measure 250 mL of the buffer solution used in the leaching procedure and transfer to the separatory funnel. Add 60 mL of methylene chloride to the separatory funnel. The TCLP leachate may be diluted to approximately 1 liter before extraction if desired.

11.2.7. Adjust sample pH as indicated in Table 1 for the initial extraction. Use the minimum amount of 1:1 H_2SO_4 or 10 N NaOH necessary. Recheck the sample with pH paper by dipping a disposable pipette into the sample and wetting the pH paper. Record adjusted pH, spiking volumes and standard numbers on the benchsheet. Return spiking solutions to the refrigerator as soon as possible.

11.2.8. Seal and shake or rotate the separatory funnel vigorously for 2 minutes with periodic venting to release excess pressure. An autoshaker may be used to shake and rotate the separatory funnel.

Warning: Dichloromethane creates excessive pressure very rapidly! Therefore, initial venting should be done immediately after the separatory funnel has been sealed and inverted. Vent into hood away from analysts and other samples.

11.2.9. Allow the organic layer to separate from the water phase until complete visible separation has been achieved (approximately 10 minutes). If the

emulsion interface between layers is more than one-third the size of the solvent layer, the analyst must employ mechanical techniques to complete the phase separation. The optimum technique depends upon the sample and may include stirring, filtration of the emulsion through glass wool, centrifugation, or other physical methods. If the emulsion cannot be broken (recovery of <80% of the methylene chloride*), transfer the sample, solvent, and emulsion into the extraction chamber of a continuous extractor and proceed as described in continuous liquid-liquid extraction (Section 11.4.). If this is done, the sample must be extracted as part of a valid CLLE batch.

*Note: 15 - 20 mL of methylene chloride is expected to dissolve in 1 L of water. Thus, solvent recovery could be as low as 35 mL from the first shake and still be acceptable. Subsequent shakes should recover at least 50 mL of solvent.

11.2.10. Fill a funnel with 10-20 g of anhydrous sodium sulfate. The funnel can be plugged with glass wool or filter paper may be used to hold the sodium sulfate. Drain the solvent extract from the separatory funnel through the prepared filtration funnel into a clean glass container. The extract may be drained directly into the KD flask. Close the stopcock just before the water level begins draining out of the separatory funnel. If the sodium sulfate becomes saturated with water add more to the funnel or replace the existing sodium sulfate with fresh drying agent.

11.2.11. Repeat the extraction process two more times using fresh 60 mL portions of solvent, combining the three solvent extracts in the collection container.

11.2.12. If extraction at a secondary pH is required, adjust the pH of the sample in the separatory funnel to the pH indicated in Table 1 with a minimum amount of 10 N NaOH or 1:1 H_2SO_4. Measure with pH paper and record the adjusted pH on the benchsheet. Serially extract with three 60 mL portions of methylene chloride, as outlined in Steps 11.2.7 to 11.2.9. Collect these three extracts in the same container used for the previous fraction.

11.2.13. Rinse the extract residue from the sodium sulfate by pouring 20-30 mL of clean methylene chloride through the funnel and into the collection container.

11.2.14. Dispose of solvent and water remaining in the extractor into the appropriate waste container.

11.2.15. Cover with aluminum foil if the extract is not concentrated immediately. Refer to Section 11.9 for concentration and Section 11.12 for cleanup.

11.3. Short-Term Continuous Liquid-Liquid Extraction

11.3.1. Extraction personnel must first determine if one liter of sample exists in the sample bottle.

11.3.2. Mark the meniscus on the side of the sample bottle for later determination of sample volume.

11.3.3. Add 225 mL methylene chloride to the extractor, turn stopcock to the open position. Connect extractor to a 250 ml boiling flask with boiling chips.

11.3.4. Check the pH of the sample and adjust, if necessary, using 1:1 H2SO4 or 10N sodium hydroxide. Quantitatively transfer the sample from the sample bottle to the extractor. *Rinse the sample bottle with 60-ml of methylene chloride. Pour the rinsate from the sample bottle into the continuous extractor.

11.3.5. Adjust the volume of solvent in the boiling flask by adding reagent water to the extractor, if necessary.

11.3.6. Next, fill the sample bottle to the mark with reagent water. Pour the reagent water into a graduated cylinder. Measure the reagent water to ± 10 ml and document this sample volume on the extraction benchsheet.

11.3.7. Add the appropriate volume of surrogate to each sample and spiking solutions to the MS, MSD, LCS, and/or LCSD in the extractor and mix well.

11.3.8. Extract samples for 12 hours. 8270 extractions will still be performed in two pH extraction steps. Each step will run 6 hours, however, where timing is a factor the samples may be left to extract for longer than 12 hours.

11.3.9. Turn stopcocks to the closed position.

11.3.10. Allow the extractors to run another 5 minutes, then turn off the rheostats and mantles.

11.3.11. The samples will macro concentrate in the CLLE. After the flasks have cooled, continue to concentrate the extracts by KD or QES methodology.

11.3.12 This method of extraction **cannot** be used for method 625, 610 or 608.

11.4 Continuous Liquid/Liquid Extraction from Water Samples.

A flow chart for this procedure is included in Section 17.

11.4.1. Assemble the apparatus. Add 250-400mL of methylene chloride to the extractor body. Add 3 to 5 boiling chips to the round-bottom distilling flask.

11.4.2. Measure the initial sample pH with wide-range pH paper and record on the extraction benchsheet. If sample is a leachate (e.g. TCLP), compare the current pH against leachate log, note on the benchsheet if there is any discrepancy.

11.4.3. Weigh the sample container on a balance (± 1 g), taring the sample and container. Transfer the sample to the continuous liquid/liquid extractor . Add the appropriate volume of surrogate spiking solution (see Table 3). Also add appropriate volume of matrix spiking solution to any matrix spike / matrix spike duplicate samples (see.Table 4) Mix well. Rinse the sample bottle with 60 mL methylene chloride and transfer to the continuous liquid/liquid extractor. Reweigh the container. Assume a density of 1 g/mL and record the difference as the sample volume on the benchsheet to the nearest milliliter.

Note: Aqueous samples must be determined volumetrically for Ohio VAP samples.

Warning: Dichloromethane creates excessive pressure very rapidly! Therefore, during the rinse for 600 series methodology venting should be done immediately after the sample container has been sealed and inverted. Vent into hood away from analysts and other samples.

11.4.3.1. If the entire sample bottle will not be used, transfer the aliquot to the extractor, then add the spiking solutions to the sample in the extractor.

Note: Alternative methods of measurement of sample volume include: a.) transferring the sample to a measuring cylinder and b.) marking a meniscus on the sample bottle and then measuring the volume of water required to fill the bottle to the meniscus after the sample is transferred. The former method is not recommended because of the risk of cross contamination while the latter is not recommended because of poor accuracy. However, either method may be necessary for specific client programs.

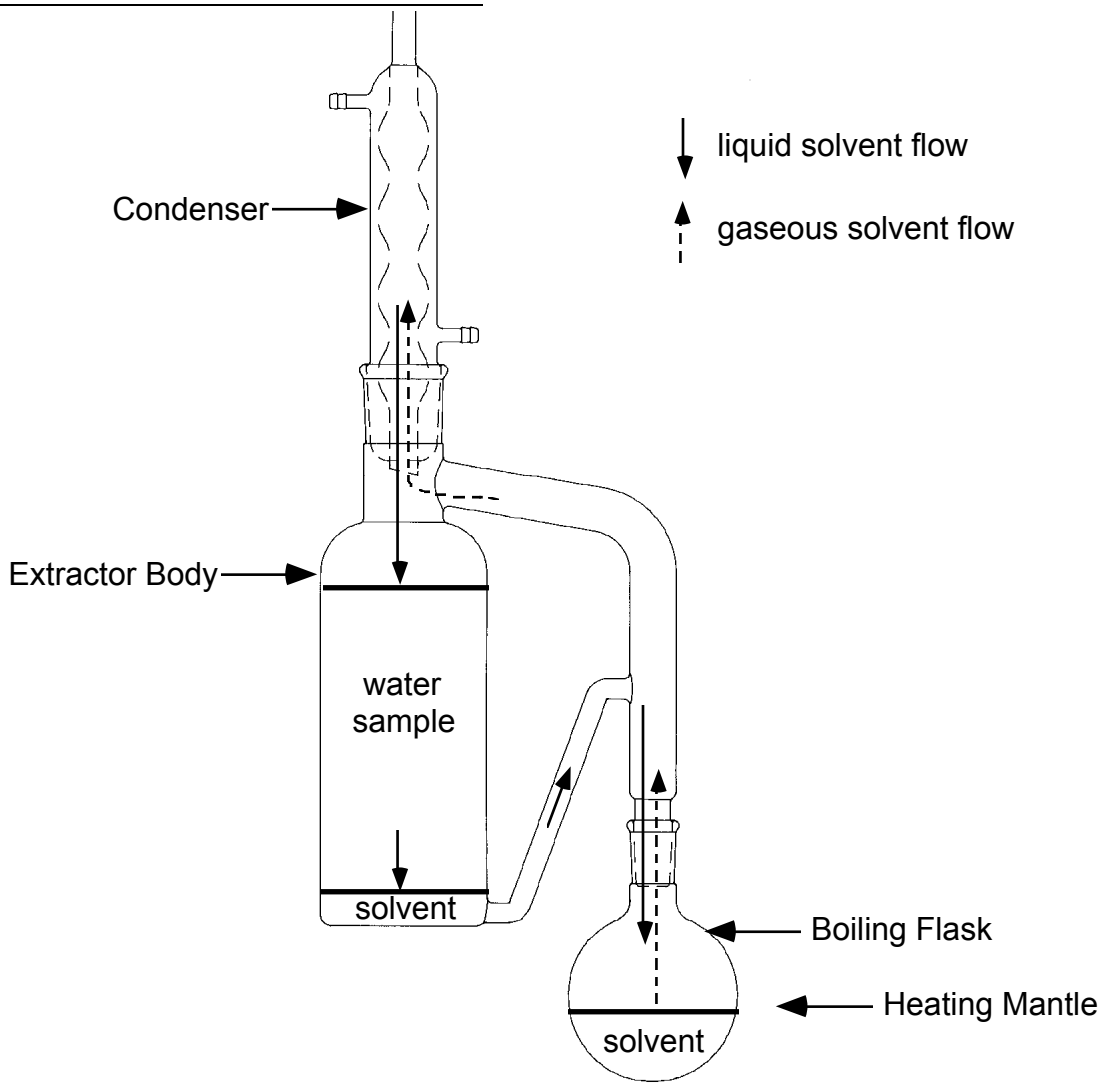
11.4.3.2.Prepare a method blank, LCS and MS/MSD for each batch as specified in Section 9 of this SOP. Use 1 L of reagent water for method blanks

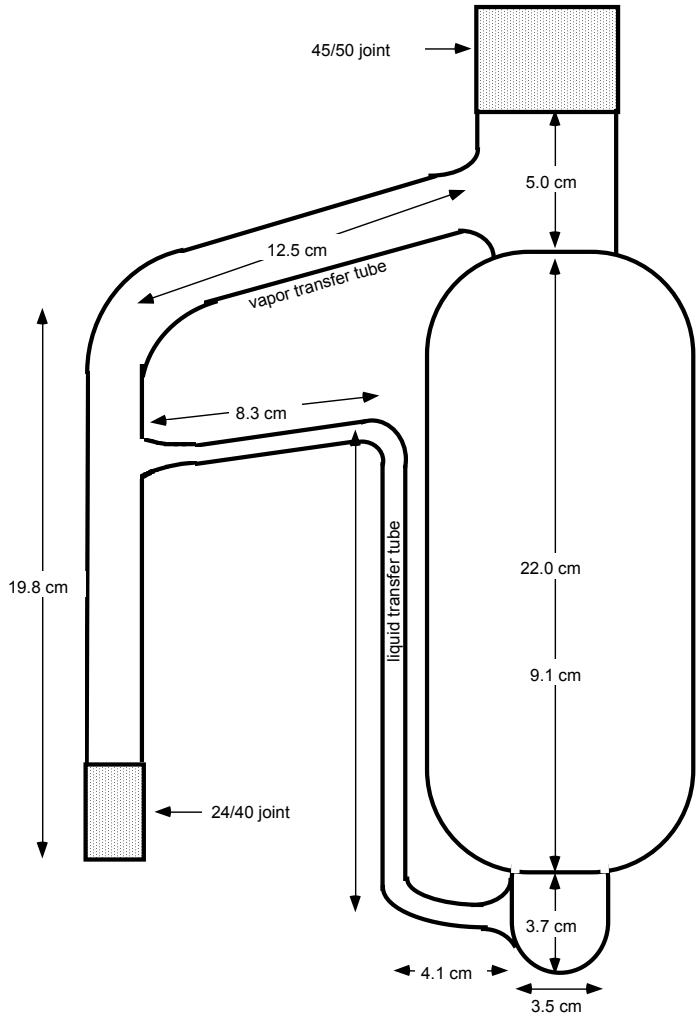
and LCS. The method blank is spiked with the surrogates, the LCS and matrix spikes with the surrogates and matrix spiking solutions.

11.4.3.3. Use 250mL of leachate for TCLP for TCLP semivolatiles and TCLP pesticides measured in a graduated cylinder. An alternative method would be to tare 400ml beaker on the balance and then add 250g to the beaker. Assume a density of 1g/mL and record the volume on the benchsheet. Dilute to about 1 liter with reagent water.

11.4.3.4. For a TCLP method blank, LCS and LCS Dup measure 250 mL of the buffer solution used in the leaching procedure and transfer to the separatory funnel. Dilute to about 1 liter with reagent water.

Less than one liter of sample may be used, for highly contaminated samples, or if the reporting limit can be achieved with less than one liter of sample. In this event dilute the sample to about 1 liter with reagent water.


liquid solvent flow
gaseous solvent flow
Condenser
Extractor Body
water sample
solvent
Boiling Flask
Heating Mantle
solvent



11.4.4. Adjust sample pH as indicated in Table 1 for the initial extraction. Use the minimum amount of 1:1 H_2SO_4 or 10 N NaOH necessary. Recheck the sample with pH paper. Record adjusted pH, spiking volumes and standard numbers on the benchsheet. Return spiking solutions to the refrigerator as soon as possible.

11.4.5. Add reagent water to the extractor body until approximately 250 mL of methylene chloride is pushed over into the round-bottomed flask to ensure proper operation and solvent cycling. Attach cold condenser (about 10°C). Turn on heating mantle. Inspect joints for leaks once solvent has begun cycling. Extract for 18-24 hours. (24 hours required for 600 series)

11.4.6. If extraction at a secondary pH is required, (see Table 1) turn off the heating mantle and allow the extractor to cool. Detach the condenser and adjust the pH of the sample in the extractor body to the pH indicated in Table 1 with a minimum amount of 10 N NaOH or 1:1 H_2SO_4. Measure with pH paper and record the adjusted pH on the benchsheet. Reattach the condenser and turn on heating mantle. Extract for 18-24 hours.

11.4.7. Turn off the heating mantle and allow the extractor to cool.

11.4.8. Place a funnel containing 10-20 g of anhydrous sodium sulfate on the Kuderna-Danish (K-D) apparatus or other glass container. The funnel can be plugged with glass wool enabling it to hold the granular anhydrous sodium sulfate or phase separation filter paper may be used.

11.4.9. Dry the extract in the round bottom flask by filtering it through the sodium sulfate filled funnel. Note that it is not necessary or advisable to attempt to add the solvent remaining in the continuous extractor body to the extract.

11.4.10. Collect the dried extract in a K-D or other glass container. Rinse the funnel with 20-30 mL of methylene chloride to complete the quantitative transfer. Dispose of solvent and water remaining in the extractor in the appropriate waste container.

Note: Some types of CLLE apparatus have built in drying columns. If this type of apparatus is used then a drying step subsequent to the extraction may not be necessary.

11.4.11. Cover with aluminum foil if the extract is not concentrated immediately. Refer to Section 11.9 for concentration and Section 11.12 for cleanup.

11.5. Sonication

A flow chart for this procedure is included in Section 17.

11.5.1. Determination of percent moisture (Optional - if a different group performs this test, refer to the facility SOP.)

In some cases, sample results are needed on a dry weight basis. If this is the case, weigh 5-10 g of sample into a suitable tared container (typically an aluminum weigh pan. Determine the % moisture by drying overnight (at least 12 hours) at 105°C. Allow to cool in a desiccator before weighing.

$$\% \text{ Moisture} = \frac{(\text{weight of wet sample} - \text{weight of dry sample})}{\text{weight of wet sample}} \times 100$$

11.5.2. Determination of pH (Optional - if a different group performs this test, refer to the facility SOP.)

If pH determination is required, transfer 10 g of soil to a beaker. Add 10 mL of water. Stir for five minutes then let stand for 1 hour. Determine the pH of the sample with a glass electrode and pH meter.

11.5.3. Decant and discard any water layer on a sediment/soil sample. Record and document if a water layer was discarded on the benchsheet. Homogenize the sample by mixing it thoroughly in the container. If this is not possible place the sample in clean beaker and homogenize. Upon completion of homogenization in beaker return sample to original container. Discard foreign objects such as sticks, leaves and rocks, unless extraction of this material is required by client. If the sample consists primarily of foreign materials consult with the client (via the Project Manager or Administrator).

11.5.4. Remove surrogate and matrix spiking solutions from refrigerator and allow to warm to room temperature.

11.5.5. Weigh 30 g of sample ± 0.2g into a 250 or 400 mL beaker. Record the weight to the nearest 0.01 g in the appropriate column on the benchsheet. Use 30 g of sodium sulfate for the method blank and 30 g of sodium sulfate with 30 g of reagent sand for the LCS.

11.5.6. Mix weighed sample with a spatula adding enough anhydrous sodium sulfate (approximately 30 g) to be free flowing. (If the sample is not free flowing extraction efficiency may be reduced)

11.5.7. Prepare a method blank, LCS and MS/MSD for each batch as specified in Section 9 of this SOP.

11.5.8. Add the appropriate volume of surrogate spiking solution (see Table 3). Also add appropriate volume of matrix spiking solution to any matrix spike / matrix spike duplicate samples (See Table 4) Add 1 mL of the surrogate spiking solution to each sample, method blank, Laboratory Control Sample (LCS), and matrix spikes. Refer to Table 6 for details of the surrogate spiking solutions. Add 1 mL of the appropriate matrix spiking solution to each Matrix Spike/Matrix Spike Duplicate (MS/MSD) and LCS.

Refer to Tables 3 and 5 for details of the spiking solutions. Record spiking volumes and standard numbers on the benchsheet. Return spiking solutions promptly to refrigerator.

Note: The same volume of surrogate and matrix spiking solution is used if GPC is indicated since the final volume would be reduced to compensate for loss of extract during the GPC procedure.

11.5.9. Immediately add a minimum of 100 mL of solvent to the beaker.

Solvents:

Semivolatile GC/MS, TPH, Organochlorine pesticides and PCBs	1:1 Methylene Chloride / Acetone

Note: Steps 11.5.5 - 11.5.9 should be performed rapidly to avoid loss of the more volatile extractables.

11.5.10. Place the bottom surface of the appropriate disrupter horn tip approximately ½ inch below the surface of the solvent, but above the sediment layer.

11.5.11. Sonicate for 3 minutes, making sure the entire sample is agitated. If the W-380 or W-385 sonicator is used the output should be set at 6 for the 3/4 inch high gain (Q) horn or 10 for the 3/4 inch standard horn. with mode switch on pulse, and percent-duty cycle knob set at 50%.

Note: Do ***not*** use ***Microtip*** probe.

11.5.12. Loosely plug the stem of a 75 mm x 75 mm glass funnel with glass wool and/or line the funnel with filter paper. Add 10-20 g of anhydrous sodium sulfate to the funnel cup.

11.5.13. Place the prepared funnel on a collection apparatus (beaker or K-D Apparatus).

11.5.14. Decant and filter extracts through the prepared funnel into a clean beaker or K-D Apparatus.

11.5.15. Repeat the extraction two more times with additional 100 mL minimum portions of solvent each time. Decant off extraction solvent after each sonication. On the final sonication pour the entire sample (sediment and solvent) into the funnel and rinse with an additional 10 mL-20 mL of the methylene chloride/acetone appropriate solvent (Refer to Table in 11.5.9).

Note: Alternatively, the three extracts may be collected together and then filtered through the sodium sulfate.

11.5.16. Cover with aluminum foil if the extract is not concentrated immediately. Refer to Section 11.9 for concentration and Section 11.12 for cleanup.

11.5.17. Sonicator Tuning: Tune the sonicator according to manufacturer's instructions. The sonicator must be tuned at least every time a new horn is installed.

11.6. Soxhlet

11.6.1. Determination of % moisture

In some cases, sample results are needed on a dry weight basis. If this is the case, weigh 5-10 g of sample into a suitable tared container (typically an aluminum weigh pan. Determine the % moisture by drying overnight at 105°C. Allow to cool in a desiccator before weighing.

$$\% \text{ Moisture} = \frac{(\text{weight of wet sample} - \text{weight of dry sample})}{\text{weight of wet sample}} \times 100$$

11.6.2. Determination of pH

If pH determination is required, transfer 10 g of soil to a beaker. Add 10 mL of water. Stir for 1 hour. Determine the pH of the sample with a glass electrode and pH meter.

11.6.3. Decant and discard any water layer on a sediment/soil sample. Record and document if a water layer was discarded on the benchsheet. Homogenize the sample by mixing it thoroughly in the container. If this is not possible place the sample in clean beaker and homogenize. Upon completion of homogenization in beaker return sample to original container. Discard foreign objects such as sticks, leaves and rocks, unless extraction of this material is required by client. If the sample consists primarily of foreign materials consult with the client (via the Project Manager or Administrator).

11.6.4. Remove surrogate and matrix spiking solutions from refrigerator and allow to warm to room temperature.

11.6.5. Weigh 30 g of sample ± 0.2g into a beaker, recording the weight to the nearest 0.01 g on the benchsheet.. Use 30 g of sodium sulfate for the method blank and LCS. Add 30 g of anhydrous sodium sulfate and mix well. The mixture should have a free flowing texture. If not, add more sodium sulfate. Add the sample/sodium sulfate mixture to a soxhlet thimble, but do not pack the thimble tightly. The extraction thimble must drain freely for the duration of the extraction period. A glass wool plug above and below the sample in the soxhlet extractor is an acceptable alternative for the thimble.

11.6.6. Add the appropriate amount of surrogate and matrix spiking solution as indicated in Tables 3, 4, 5, and 6.

Sample weights less than 30 g but over 5 g may be used if the appropriate reporting limits can be met.

11.6.7. Prepare a method blank, LCS and MS/MSD for each batch as specified in Section 9 of this SOP, using sodium sulfate as the matrix. The weight of sodium sulfate used should be approximately the weight of soil used in each sample.

11.6.8. Place approximately 200mL of solvent into a 250 mL flat bottom flask containing one or two clean boiling chips. Attach the flask to the extractor and extract the sample for 16-24 hours at 4-6 cycles per hour. Check the system for leaks at the ground glass joints after it has warmed up.

NOTE: If a reduced quantity of sample is extracted, it is usually necessary to increase the amount of sodium sulfate added or increase the solvent boiling rate to properly set the cycling rate.

Solvents:

Semivolatile GC/MS, OPP, PAH, TPH Organochlorine pesticides and PCBs	1:1 Methylene Chloride / Acetone

11.6.9. Allow the extract to cool after the extraction is complete, then disassemble by gently twisting the soxhlet from the flask. Dry the extract in the flask by filtering it through a sodium sulfate filled funnel.

11.6.10. Collect the dried extract in a K-D or other glass container. Rinse the flask which contained the solvent extract with 20-30 mL of methylene chloride and add it to the funnel to complete the quantitative transfer.

11.6.11. Cover with aluminum foil if the extract is not concentrated immediately. Refer to Section 11.9 for concentration and Section 11.12 for cleanup.

11.7. Accelerated Soxhlet (Soxtherm Trade Name)

11.7.1. Demonstration of % moisture

In some cases, sample results are needed on a dry weight basis. If this is the case, weigh 5-10 g of sample into a suitable tared container (typically an aluminum weigh pan. Determine the % moisture by drying overnight at 105°C. Allow to cool in a desiccator before weighing.

$$\%Moisture = \frac{\text{(Weight of wet sample – Weight of dry sample)}}{\text{Weight of wet sample}} \times 100$$

11.7.2. Determination of pH
If pH determination is required, transfer 10 g of soil to a beaker. Add 10 mL of water. Stir for 1 hour. Determine the pH of the sample with a glass electrode and Ph meter.

11.7.3. Decant and discard any water layer on a sediment/soil sample. Record and document if a water layer was discarded on the benchsheet. Homogenize the sample by mixing it thoroughly in the container. If this is not possible, place the sample in clean beaker and homogenize. Upon completion of homogenization in beaker, return sample to original container. Discard foreign objects such as sticks, leaves and rocks, unless extraction of this material is required by client. If the sample consists primarily of foreign materials, consult with the client (via the Project Manager or Administrator).

11.7.4. Remove surrogate and matrix spiking solutions from refrigerator and allow to return to room temperature.

11.7.5. Weigh 30 g of sample ± 0.2 g into a beaker, recording the weight to the nearest 0.01 g on the benchsheet. Use 30 g of sodium sulfate for the method blank and LCS. Add 30 g of anhydrous sodium sulfate and mix well. The mixture should have a free flowing texture. If not, add more sodium sulfate. Add the sample/sodium sulfate mixture to a soxhlet thimble, but do not pack the thimble tightly. The extraction thimble must drain freely for the duration of the extraction period. A glass wool plug above and below the sample in the thimble is required.

11.7.6. Add the appropriate amount of surrogate and matrix spiking solution as indicated in Tables 3, 4, 5, and 6.

11.7.7. Sample weights less than 30 g, but over 5 g may be used if the appropriate reporting limits can be met.

11.7.8. Prepare a method blank, LCS and MS/MSD for each batch as specified in Section 9 of this SOP, using sodium sulfate as the matrix. The weight of sodium sulfate used should be approximately the weight of soil used in each sample.

11.7.9. Place thimble in beaker containing clean boiling chips and add approximately 140 mL of solvent. Place beakers into positions on the accelerated soxhlet unit. Run appropriate program for the extraction solvent. Check the system for leaks at the joints periodically.

Solvents:

Semivolatile MS, PAH, TPH	1:1 Methylene Chloride / Acetone
Semivolatile GC PCB, PEST, OPP	1:1 Hexane/Acetone

11.7.10. Upon completion of the program, remove the beaker from the unit and dispose of the extracted sample. Dry the extract in the flask by filtering it through a sodium sulfate filled funnel.

11.7.11. Collect the dried extract in a K-D, TurboVap tube, or other glass container. Rinse the flask which contained the solvent extract with 10-15 mL of methylene chloride and pour it through the funnel. Rinse the funnel with 10-15 mL of methylene chloride to complete the quantitative transfer.

11.7.12. Cover with aluminum foil if the extract is not concentrated immediately. Refer to Section 11.9 for concentration and Section 11.12 for cleanup.

11.8. Waste Dilution

11.8.1. This method is used for materials that are soluble in an organic solvent.

11.8.2. Transfer 10 mL of the solvent to be used for dilution into a Teflon capped vial. Mark the meniscus on the vial, then discard the solvent.

11.8.3. Tare the vial, then transfer approximately 1g of sample to the vial. Record the weight to the nearest 0.01 g.

11.8.4. Add appropriate volume of surrogate and spike solutions (Table 3).

11.8.5. Dilute to 10 mL with the appropriate solvent. (Methylene Chloride for GC/MS- and GCS-TPH. Add 10 mL of appropriate solvent (Hexane) for GCS-pesticide and/or PCB analysis.

11.8.6. Add 2 g + 0.1 g sodium sulfate to the sample. Cap and shake or vortex each extract for 2 minutes.

11.8.7. If H2O is still present, add 4-5 g sodium sulfate to a small pipette funnel. The funnel can be plugged with glass wool or phase separation filter paper may be used to hold the sodium sulfate.

11.8.8. Pour the sample through the funnel, collecting as much as possible in a clean vial. Do NOT rinse the funnel with additional solvent, and do NOT concentrate the sample. The final volume is defined as 10 mL.

11.8.9. Label the sample, which is now ready for cleanup or analysis.

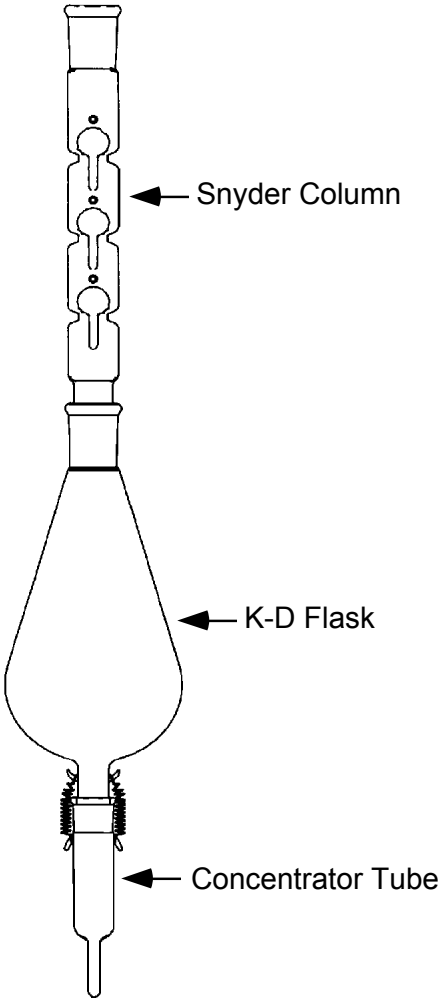
11.9. Concentration

According to the type of sample and any cleanup procedures needed, different final solvents and volumes will be required. Refer to Table 2 for the appropriate final volumes and concentrations.

11.9.1. Kuderna-Danish (KD) Method:

11.9.1.1. Assemble a Kuderna-Danish concentrator by attaching a 10 mL concentrator tube to the 500 mL KD flask. Transfer the sample to the K-D flask.

11.9.1.2. Add one or two clean boiling chips and the extract to be concentrated to the KD flask and attach a three ball Snyder Column. Add approximately 1 mL of clean methylene chloride to the top of the Snyder column (this is important to ensure that the balls are not stuck and that the column will work properly).



11.9.1.3. Place the KD apparatus on a water bath (90-98°C) so that the tip of the concentrator tube is submerged. The water level should not reach the joint between the concentrator and the KD flask. At the proper rate of distillation, the balls will actively chatter but the chambers should not flood.

11.9.1.4. Concentrate to 5-15 mL. If the determinative method requires a solvent exchange add the appropriate exchange solvent (50 mL hexane, 20 ml hexane/acetone, or 4 mL acetonitrile,4mL toluene (Herbicide TCLP), or 10 mL toluene) to the top of the Snyder Column, and then continue the water bath concentration back down to 1-4 mL. Refer to Table 2 for details of exchange solvents and final volumes. The Snyder column may be insulated if necessary to maintain the correct rate of distillation.

Note: Add an additional boiling chip with the addition of exchange solvent.

An alternative technique for solvent exchange is to replace the macro Snyder column and KD flask with a micro Snyder column, concentrate to approximately 1 mL, add the appropriate solvent, and concentrate back down to 1 mL. The extract must be cool before the macro Snyder assembly is removed.

Note: It is very important not to concentrate to dryness as analytes will be lost.

11.9.1.5. Remove the KD apparatus from the water bath and allow to cool for a minimum of 10 minutes. If the level of the extract is above the level of the concentrator tube joint, continue to distill the solvent as necessary. Again, allow the KD flask to cool for a minimum of 10 minutes.

11.9.1.6. If the final volume is 5 or 10 mL the extract may be made up to volume in the graduated KD tube or transferred to a 12 mL vial previously marked at the appropriate volume level. Document the final volume. Otherwise proceed to Section 11.10

11.10. Nitrogen Evaporation to Final Concentration

11.10.1. Transfer the entire extract to a calibrated evaporation tube. Rinse the concentrator tube with 1-2 mL of the appropriate solvent and transfer the solvent rinsate to the evaporation tube.

11.10.2. Place the tube in a warm water bath that is at least 5°C below the boiling temperature of the solvent being evaporated and evaporate the solvent using a gentle stream of nitrogen. The nitrogen flow will form a slight depression on the surface of the solvent, but should not create splattering of the extract.

Boiling points of commonly used solvents are:

Methylene chloride	40°C
Acetone	56°C
Hexane	69°C
Acetonitrile	82°C
Toluene	111°C

11.10.3. During the course of the evaporation rinse the sides of the evaporation tube twice with approximately 1 mL of clean solvent. The first rinse should be about half way through he process, with the second rinse when the solvent volume gets close to 1 mL. Concentrate the solvent accurately to the calibrated volume line and transfer the extract to the appropriate storage vial.

Note: It is very important not to concentrate to dryness as analytes will be lost.

An alternative technique is to follow the previous steps concentrating the solvent to slightly below the required final volume and then drawing the extract into a syringe. Rinse the evaporation tube with a small amount of solvent and draw additional solvent into the syringe to make up the accurate final volume.

Note: It is very important not to concentrate to dryness as analytes will be lost.

Note: The final concentration and volume measurement steps are critical. Use care when concentrating and make certain that the final volume measurement is accurate.

Alternative QES Concentration Method:

This concentration method uses a hot water jacketed concentrator tube (CT) instead of the hot water bath and concentrator tube used in Section 11.9.1.1. The construction of the jacketed concentrator tube reduces the tendency of the extract to evaporate to dryness. Thus, low boiling analytes are retained in the extract better with less analyst monitoring of the concentration process.

Assemble the jacketed concentrator tube, KD body and hot water hoses. Add 1mL of exchange solvent (if needed) and one large, clean boiling chip.

NOTE*: The boiling chips used in the jacketed concentrator tube must be large enough to prevent them falling down into the tip of the CT. If the boiling chip is not in the proper position, the*

extract may superheat and bump vigorously if the extract solvent warms up slowly.

Pour the extract to be concentrated into the KD flask, and attach a three-ball Snyder column.

Turn on the hot (95°C) water flow to the jacketed concentrator tube.

Concentrate to 1 mL. If the determinative method requires a solvent exchange, add the appropriate exchange solvent (5-10 mL hexane, 1 mL acetonitrile, 4 mL acetone/hexane) to the top of the Snyder column. Continue to concentrate until the Snyder column balls stop chattering.

Cool the jacketed concentrator tube until it is cold to the touch.

Quantitatively transfer the extract and dilute to final volume, or continue concentration with nitrogen evaporation (Section 11.10).

11.11. Turbovap Method

11.11.1. Turn on the Turbovap and adjust the water temperature to 5-10°C less than the boiling point of the solvent to be evaporated.

11.11.2. Switch all endpoint sensors to the correct position.

11.11.3. Adjust the water bath level

11.11.4. Adjust the nitrogen gas pressure to approximately 14 psi.

11.11.5. Transfer the extract into the Turbovap tube and load into the Turbovap. Do not fill the Turbovap tubes over approximately 3/4 full.

11.11.6. Reset the sensor and close the lid.

Note: If the extract splashes when the nitrogen flow starts, reduce the nitrogen flow or transfer a portion of the extract back into the original extract container.

11.11.7 As the extract concentrates, transfer the remainder of the extract into the appropriate Turbovap tube. After all of the extract has been

transferred, rinse the flask with a few mL of methylene chloride and add to the Turbovap tube.

11.11.8. Concentrate the extract to slightly less than the required final volume.

11.11.9. If solvent exchange is required, concentrate to 1-4 mL and add appropriate volume of the exchange solvent. Concentrate back down to the appropriate volume. Refer to Table 2 for details of exchange solvents and final volumes.

11.11.10. Transfer the concentrated extract to volumetric glassware for adjustment of final volume, using a small amount of solvent to rinse the tube and complete the transfer.

> ***Note:*** Water contamination from condensation during concentration is not acceptable. If water is present, remove the Turbovap tube and filter the extract through sodium sulfate. Transfer to a clean Turbovap tube and continue the concentration.
> ***Note 2***: Dark, opaque or turbid samples may not concentrate. If this occurs, supervise the entire concentration procedure.

11.12. Cleanup Techniques

11.12.1. The following techniques may be used to remove interfering peaks, and /or to remove materials that may cause column deterioration and/ or loss of detector sensitivity.

11.12.2. *Gel Permeation Chromatography* (Section 11.13) is a generally applicable technique which can be used to prepare extracts for Semivolatiles (8270), and pesticides (8081) analysis. It is capable of separating high molecular weight material from the sample analytes, and so is particularly useful if tissue or vegetable matter is part of the sample, and for many soil samples. Note: GPC used only for CLP Projects

11.12.3. *Florisil column cleanup* (Section 11.21) is particularly useful for cleanup of pesticides for analysis by method 8081 and should normally be applied to these samples unless the matrix is clean. It separates compounds with a different polarity from the target analytes. Note: GPC used only for CLP Projects. Gel Permeation Chromatography and Florisil column cleanup may both be applied to samples for analysis by method 8081/8082. In this case the GPC should be performed first.

11.12.4. *Sulfur cleanup* (Section 11.23) is generally applied to samples for analysis by method 8081/8082, since the Electron Capture Detector responds strongly to sulfur. It is performed after GPC and Florisil cleanup.

11.12.5. *Sulfuric acid cleanup* (Section 11.24) is applied to samples requiring analysis for Polychlorinated Biphenyls (PCBs) only. Most organic matter is destroyed by the sulfuric acid. WARNING: Sulfuric acid cleanup must not be performed on any matrix that may have water present as a violent reaction between the acid and water may result in acid exploding out of the vessel.

11.12.6. Acid Base Partition Cleanup (Section 11.25) is useful for separating organic acids and phenols from basic and neutral organics.

11.12.7. Fluorocarbon cleanup (Section 11.26) is used to remove hydrocarbons from water samples to be analyzed for water soluble alcohols.

11.13. Gel Permeation Chromatography (GPC)

Note: GPC system used is J2 Scientific Accuprep.

11.14. GPC Column Preparation

11.14.1. Weigh out 70 g of Bio Beads (SX-3) into a 400-mL beaker.

11.14.2. Add approximately 300 mL of methylene chloride and stir gently.

11.14.3. Cover with aluminum foil and allow the beads to swell for a minimum of two hours. Maintain enough solvent to sufficiently cover the beads at all times.

11.14.4. Position and tighten the outlet bed support (top) plunger assembly in the tube by inserting the plunger and turning it clockwise until snug. Install the plunger near the column end but no closer than 5 cm (measured from the gel packing to the collar).

11.14.5. Turn the column upside down from its normal position with the open end up. Place the tubing from the top plunger assembly into a waste beaker below the column.

11.14.6. Swirl the bead/solvent slurry to get a homogeneous mixture and pour the mixture into the open end of the column. Transfer as much as possible with one continuous pour trying to minimize bubble formation. Pour enough to fill the column. Wait for the excess solvent to drain out before pouring in the rest. Add additional

methylene chloride to transfer the remaining beads and to rinse the beaker and the sides of the column. If the top of the gel begins to look dry, add more methylene chloride to rewet the beads.

11.14.7. Wipe any remaining beads and solvent from the inner walls of the column with a laboratory tissue. Loosen the seal slightly on the other plunger assembly (long plunger) and insert it into the column. Make the seal just tight enough so that any beads on the glass surface will be pushed forward, but loose enough so that the plunger can be pushed forward.

CAUTION: Do not tighten the seal if beads are between the seal and the glass surface because this can damage the seal and cause leakage.

11.14.8. Push the plunger until it meets the gel, then compress the column bed about 4 cm.

11.14.9. Connect the column inlet to the solvent reservoir and place the column outlet tube in a waste container. Pump methylene chloride through the column at a rate of 5 mL/min. for one hour.

11.14.10. After washing the column for at least one hour, connect the column outlet tube to the inlet side of the UV detector. Connect the system outlet to the outlet side of the UV detector. Placing a restrictor (made from a piece of capillary tubing of 1/16"OD x 10/1000”ID x 2”) in the outlet tube from the UV detector will prevent bubble formation which causes a noisy UV baseline. The restrictor will not effect the flow rate. After pumping methylene chloride through the column for an additional 1-2 hours, adjust the inlet bed support plunger until approximately 6-10 psi back-pressure is achieved. Push the plunger in to increase pressure or slowly pull outward to reduce pressure.

11.14.11. When the GPC column is not to be used for several days, connect the column inlet and outlet lines to prevent column drying and/or channeling. If channeling occurs, the gel must be removed from the column, re-swelled, and re-poured as described above. If drying occurs, pump methylene chloride through the column until the observed column pressure is constant and the column appears wet. Always recalibrate after column drying has occurred to verify that retention volumes have not changed.

11.15. Initial Calibration of the GPC Column

11.15.1. Before use, the GPC must be calibrated based on monitoring the elution of standards with a UV detector connected to the GPC column.

11.15.2. Pump solvent through the GPC column for 2 hours. Verify that the flow rate is 4.5-5.5 mL/min. Corrective action must be taken if the flow rate is outside this range. Record the column pressure (should be 6-10 psi) and room temperature (22°C is ideal).

Note: Changes in pressure, solvent flow rate, and temperature conditions can affect analyte retention times and must be monitored. If the flow rate and/or column pressure do not fall within the above ranges, a new column should be prepared.

11.15.3. Inject the calibration solution and retain a UV trace that meets the following requirements (See resolution calculation in Section 11.20.1.):

- Peaks must be observed and should be symmetrical for all compounds in the calibration solution.
- Corn oil and phthalate peaks must exhibit >85% resolution.
- Phthalate and methoxychlor peaks must exhibit >85% resolution.
- Methoxychlor and perylene peaks must exhibit >85% resolution.
- Perylene and sulfur peaks must not be saturated and must exhibit >90% baseline resolution.

11.15.4. A UV trace that does not meet the criteria in Section 11.15.1. indicates the need for system maintenance and/or the need for a new column.

11.15.5. Determine appropriate collect and dump cycles.

11.15.6. The calibrated GPC program for pesticides/PCB should dump >85% of the phthalate and should collect >95% of the methoxychlor and perylene. Use a wash time of 10 minutes.

11.15.7. For semivolatile extracts, initiate a column eluate collection just before the elution of bis (2-ethylhexyl) phthalate and after the elution of the corn oil. Stop eluate collection shortly after the elution of perylene. Stop collection before sulfur elutes. Use a wash time of 10 minutes after the elution of sulfur.

11.15.8. Reinject the calibration solution after appropriate dump and collect cycles have been set.

11.15.9. Measure and record the volume of collected GPC eluate in a graduated cylinder.

11.15.10. The retention times for both bis(2-ethylhexyl) phthalate and perylene must not vary more than +/- 5% between calibrations.

11.16. GPC calibration check

11.16.1. Check the calibration of the GPC immediately after the initial calibration and at least every 7 days thereafter, while the column is in use.

11.16.2. Inject the calibration solution, and obtain a UV trace. If the retention times of bis(2-ethylhexyl)phthalate or perylene have changed by more than ± 5% use this run as the start of a new initial calibration. Otherwise, proceed with the recovery check. Excessive retention time shifts may be caused by poor laboratory temperature control or system leaks, an unstabilized column, or high laboratory temperature causing outgassing of methylene chloride. Pump methylene chloride through the system and check the retention times each day until stabilized.

11.17. GPC Recovery Check for Pesticides/ PCBs

11.17.1. The recovery from the GPC must be verified immediately after the initial calibration and at least every 7 days, when the instrument is in use. Two recovery check solutions are used. The first mixture is prepared by diluting 1.0 2.0 mL of the pesticide matrix spiking solution (Table 6) to 10 mL in methylene chloride. The second mixture is prepared by diluting 12.0 mL of the PCB only matrix spiking solution (Table 6) to 10 mL with methylene chloride.

11.17.2. Load the pesticide matrix spike mixture, the PCB mixture, and a methylene chloride blank onto the GPC using the GC dump and collect values.

Note: If the analysis is for PCBs only, then the pesticide recovery check is not necessary.

11.17.3. After collecting the GPC calibration check fraction, concentrate, solvent exchanging to hexane. Adjust the final volume to 5.0 mL, and analyze by GC/EC. Refer to concentration, Section 11.9.

11.17.4. The methylene chloride blank may not exceed more than one half the reporting limit of any analyte. And if the recovery of each of the single component analytes is 80-10120% and if the Aroclor pattern is the same as previously run standards, then the analyst may use the column. If the above criteria are not met, there may be a need for system maintenance.

11.18. GPC Blank for Semivolatiles

11.18.1. The recovery from the GPC must be verified immediately after the initial calibration and at least every 7 days, when the instrument is in use.

11.18.2. Load a methylene chloride blank onto the GPC using the semivolatiles dump and collect values.

11.18.3. After collecting the GPC recovery check fraction, concentrate, and analyze by GC/MS. Refer to the concentration Section 11.9.

The blank should not contain any analytes at or above the reporting limit. If these conditions are met the column may be used for sample analysis. Otherwise correct the contamination problem, or extend the collect time to improve recovery of target analytes.

11.19. Sample Extract Cleanup

11.19.1. Reduce the sample extract volume to 1-2 mL, then adjust to 10 mL with methylene chloride prior to cleanup. This reduces the amount of acetone in the extract. Refer to Section 11.9.

11.19.2. Start the pump and let the flow stabilize for 2 hours. The solvent flow rate should be 4.5-5.5 mL/min. The ideal laboratory temperature to prevent outgassing of the methylene chloride is 22°C. The normal backpressure is 6-10 psi.

11.19.3. In order to prevent overloading of the GPC column, highly viscous sample extracts must be diluted prior to cleanup. Any sample extract with a viscosity greater than that of a 1:1 glycerol:water solution (by visual comparison) must be diluted and loaded into several loops.

11.19.4. Samples being loaded onto the GPC should be filtered with a 5 micron (or less) filter disk. Attach a filter to a 10 mL Luerlok syringe and filter the 10 mL sample extract into the sample tube.

11.19.5. Load the filtered samples into the proper sample tubes and place on the GPC.

11.19.6. Set the collect, dump, and wash times determined by the calibration procedure.

11.19.7. Switch to the run mode and start the automated sequence. Process each sample using the collect and dump cycle times established by the calibration procedure.

11.19.8 Collect each sample in a suitable glass container. Monitor sample volumes collected.

11.19.9. Any samples that were loaded into 2 or more positions must be recombined.

11.19.10. Concentrate semivolatile sample extracts to 0.5 mL in methylene chloride. Refer to the concentration Section 11.9.

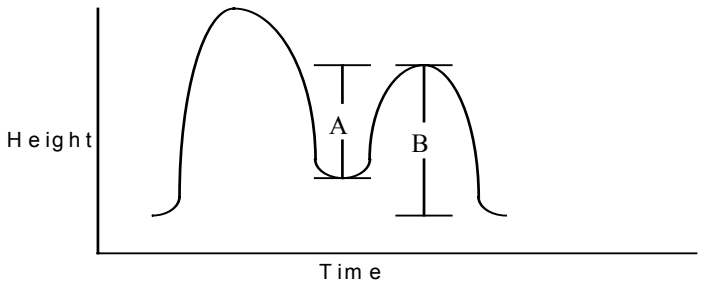
11.19.11. Solvent exchange pesticide/PCB sample extracts into hexane and concentrate to 5.0 mL. Refer to the concentration Section 11.9.

11.20. Calculations

11.20.1. Resolution

To calculate the resolution between two peaks on a chromatograph, divide the depth of the valley between the peaks by the peak height of the smaller peak being resolved and multiply by 100.

Resolution Calculation



$$\% \text{ Resolution } = \frac{A}{B} \times 100$$

Where: A = depth of valley to height of smaller peak

B = peak height of smaller peak

11.20.2. Dump Time

Mark on the chromatograph the point where collection is to begin. Measure the distance from the injection point. Divide the distance by the chart speed. Alternatively the collect and dump times may be measured by means of an integrator or data system.

$$\text{Dump time (min)} = \frac{\text{Distance (cm) from injection to collection start}}{\text{Chart speed (cm / min)}}$$

11.20.3. Collection Time

$$\text{Collection time (min)} = \frac{\text{Distance (cm) between collection start and stop}}{\text{Chart speed (cm / min)}}$$

11.21. Florisil Cartridge Cleanup

Florisil cleanup is generally used for organochlorine pesticides, although it may be applied to other analytes. Sections 11.21.1 through 11.21.8 outline the procedure for organochlorine pesticides, while section 11.22 outlines modifications required for other analytes.

Note 1: Systems for eluting multiple cleanup cartridges include the Supelco, Inc. Solid Phase Extraction (SPE) assembly or equivalent.

Note 2: Follow the lab specific procedure when using ABC Model 1002B.

11.21.1. Before Florisil cleanup sample volume must be reduced to 10 mL (5 mL if GPC cleanup was used) and the solvent must be hexane. Refer to Section 11.9 for details of concentration.

11.21.2. Attach a vacuum manifold to a vacuum pump or water aspirator with a trap installed between the manifold and the vacuum. Adjust the vacuum in the manifold to 5-10 psi.

11.21.3. Place one Florisil cartridge into the vacuum manifold for each sample extract. Prior to cleanup of samples, pre-elute each cartridge with 5 mL of hexane/acetone (9:1). Adjust the vacuum applied to each cartridge so that the flow through each cartridge is approximately 2 mL/min. Do not allow the cartridges to go dry.

11.21.4. Just before the cartridges go dry, release the vacuum to the manifold and remove the manifold top.

11.21.5. Place a rack of clean labeled 12 mL concentrator tubes into the manifold and replace the manifold top. Make sure that the solvent line from each cartridge is placed inside the appropriate tube.

11.21.6. After the clean tubes are in place, vacuum to the manifold is restored and 2.0 mL of the extract is added to the appropriate Florisil cartridge.

11.21.7. The pesticides/aroclors in the extract concentrates are then eluted through the column with 8 mL of hexane/acetone (90:10) and are collected into the 10 mL culture tube or concentrator tube held in the rack inside the vacuum manifold.

11.21.8. Transfer the extract to a graduated concentrator tube and concentrate the extract to 2 mL. Refer to the concentration Section. (11.9)

Note 1: A cartridge performance standard must be run with each lot of Florisil cartridges.

Note 2: Florisil cartridge performance check--every lot number of Florisil must be tested before use. Add 0.5 ug/mL of 2,4,5-trichlorophenol solution and 0.5 mL of GC Standard Mix A (midpoint concentration) to 4 mL hexane. Reduce volume to 0.5 mL. Add the concentrate to a pre-washed Florisil cartridge and elute with 9 mL hexane/acetone [(90:10)(v/v)]. Rinse cartridge with 1.0 mL hexane two additional times. Concentrate eluate to 1.0 mL final volume and transfer to vial. Analyze the solution by GC/EC. The test sample

must show 80 to 120% recovery of all pesticide analytes with <5% trichlorophenol recovery, and no peaks interfering with target compounds can be detected. This standard has a lifetime of six months. Alternatively, this standard may be purchased as a stock solution.

11.22. Modifications for other analyte classes

11.22.1.PCBs

Pre-elute the cartridge with 4 mL hexane. Add 2 mL of the sample extract and elute with 3 mL hexane. The eluant will contain the PCBs together with any heptachlor, aldrin, 4,4'DDE and part of any 4,4'DDT. Any BHC isomers, heptachlor epoxide, chlordane, endosulfan I and II, endrin aldehyde and endrin sulfate and methoxychlor will be retained on the column and can be eluted in a separate fraction with 8 mL 90:10 hexane:acetone if required.

11.23. Sulfur Removal

11.23.1. Sulfur can be removed by one of three methods: mercury, copper, or tetrabutylammonium sulfite (TBA) according to laboratory preference. If the sulfur concentration is such that crystallization occurs in the concentrated extract, centrifuge the extract to settle the crystals, and carefully draw off the sample extract with a disposable pipet, leaving the excess sulfur in the centrifuge tube. Transfer the extract to a clean concentrator tube before proceeding with further sulfur cleanup.

11.23.2. Sulfur Removal with Elemental Mercury

Note: Use Mercury sparingly in order to minimize exposure and disposal costs.

11.23.2.1. Transfer 2 mL of sample extract into a clean concentrator tube or Teflon sealed vial.

11.23.2.2. Add one to three drops of mercury to the extract vial and seal.

11.23.2.3. Shake well for 15-30 seconds. If prolonged shaking is required, use a mechanical shaker.

11.23.2.4. Remove the extract from the mercury using a disposable pipette and transfer to a clean vial.

11.23.2.5. If black precipitate forms, sulfur was present. Shake again, then centrifuge. After centrifugation, transfer the supernate to a clean test tube and repeat. Do this until relatively little

precipitate remains, or the screens indicate that cleanup is complete.

11.23.2.6. Properly dispose of the mercury waste.

11.23.3. Sulfur Removal with Copper

11.23.3.1. Transfer 1.0 mL of sample extract into a centrifuge or concentrator tube.

11.23.3.2. Add approximately 2 g of cleaned copper powder (see Section 7.2 for copper cleaning procedure) to the sample extract tube.

11.23.3.3. Mix for one minute on a mechanical shaker.

11.23.3.4. If the copper changes color, sulfur was present. Repeat the sulfur removal procedure until the copper remains shiny.

11.23.3.5. Transfer the supernate to a clean vial.

11.23.4. Sulfur Removal with Tetrabutylammonium (TBA) Sulfite Reagent

11.23.4.1. Transfer 1.0 mL of sample extract into a culture tube.

11.23.4.2. Add 1.0 mL TBA sulfite reagent and 2 mL 2-propanol to the sample extract. Cap and shake for 1 minute. If clear crystals (precipitated sodium sulfite) form, sufficient sodium sulfite is present.

11.23.4.3. If a precipitate does not form, add sodium sulfite in an approximately 0.1 g portions until a solid residue remains after repeated shaking.

11.23.4.4. Add 5 mL organic free reagent water and shake for 1 minute. Allow sample to stand for 5-10 minutes. (Centrifuge if necessary to separate the layers). Transfer the sample extract (top layer) to a vial. The final volume is defined as 1.0 mL in Section 11.23.4.1.

11.24. Sulfuric Acid Cleanup

11.24.1. Add approximately 2-5 mL of concentrated sulfuric acid to 2 mL of sample extract in a Teflon capped vial.

Caution: There must be no water present in the extract or the reaction may shatter the sample container.

11.24.2. Shake or vortex for about thirty seconds and allow to settle. (Centrifuge if necessary)

11.24.3. Remove the sample extract (top layer) from the acid using a Pasteur pipette and transfer to a clean vial. ***CAUTION:*** It is not necessary to remove all the extract since the final volume is already determined. Transfer of small amounts of sulfuric acid along with the extract will result in extremely rapid degradation of the chromatographic column.

11.24.4. If the sulfuric acid layer becomes highly colored after shaking with the sample extract, transfer the hexane extract to a clean vial and repeat the cleanup procedure until color is no longer being removed by the acid, or a maximum of 5 acid cleanups.

11.24.5. Properly dispose of the acid waste.

11.25. Acid/Base Partition Cleanup

11.25.1. Place 10 mL of the solvent extract from a prior extraction procedure into a 125 mL separatory funnel.

11.25.2. Add 20 mL of methylene chloride to the separatory funnel.

11.25.3. Slowly add 20 mL of DI water which has been previously adjusted to a pH of 12 to 13 with 10 N sodium hydroxide.

11.25.4. Seal and shake the separatory funnel for at least two minutes with periodic venting to release excess pressure.

CAUTION: Methylene chloride creates excessive pressure very rapidly. Initial venting should be done immediately after the separatory funnel has been sealed.

11.25.5. Allow the organic layer to separate from the aqueous phase for a minimum of ten minutes.

11.25.6. If an emulsion interface between layers is more than one-third the size of the solvent layer, the analyst must employ mechanical techniques to complete the phase separation. The optimum technique depends upon the sample, and may include stirring, filtration of the emulsion through glass wool, centrifugation, or other physical methods.

11.25.7. Separate the aqueous phase and transfer it to a 125 mL Erlenmeyer flask. Repeat the extraction two more times using fresh 20 mL aliquots of dilute sodium hydroxide (pH 12-13) . Combine the aqueous extracts.

11.25.8. Water-soluble organic acids and phenols will be primarily in the aqueous phase. Base/neutral analytes will be in the methylene chloride. If the analytes of interest are only in the aqueous phase discard the methylene chloride and proceed to Section 11.25.9. If the analytes of interest are only in the methylene chloride, discard the aqueous phase and proceed to Section 11.25.11.

11.25.9. Externally cool the flask with ice while adjusting the aqueous phase to a pH of 1-2 with sulfuric acid (1:1). Transfer the cool aqueous phase to a clean 125 mL separatory funnel.

11.25.10. Add 20 mL of methylene chloride to the separatory funnel and shake for at least two minutes. Allow the methylene chloride to separate from the aqueous phase and collect the methylene chloride in an Erlenmeyer flask. Repeat the extraction two more times using fresh methylene chloride and extracting at pH 1-2. Combine the three extracts.

11.25.11. Dry the extract by passing through a funnel containing 10-20 g anhydrous sodium sulfate. Rinse the funnel with an additional 20-30 mL of clean methylene chloride

11.25.12. Cover with aluminum foil if the extract is not concentrated immediately. Refer to Section 11.9 for concentration.

11.25.13. Dispose of solvent and water remaining in the separatory funnel into the appropriate waste container.

11.26. Fluorocarbon Cleanup

This procedure is appropriate for the removal hydrocarbons from water samples prior to analysis for water soluble alcohols

11.26.1. Transfer 1-2 mL of water sample to a 10 mL culture tube.

11.26.2. Add 1-2 mL of fluorocarbon solvent (PF-5080) to the culture and cap.

11.26.3. Shake for 30-60 seconds.

11.26.4. After the two phases have separated, pipette about 1 mL of water sample (top layer) into an autosampler vial for analysis. If necessary, centrifuge to enhance the phase separation.

12. DATA ANALYSIS AND CALCULATIONS

Not applicable

13. METHOD PERFORMANCE

13.1. Method Detection Limit

Each laboratory must generate a valid method detection limit for each analyte of interest. The procedure for the determination of the method detection limit is given in STL North Canton QA Policy #: QA-005

13.2. Initial Demonstration

Each laboratory must make an initial demonstration of capability for each individual method. This requires analysis of four QC Check samples. The QC check sample is a well-characterized laboratory generated sample used to monitor method performance, which should contain all the analytes of interest. The spiking level should be equivalent to a mid-level calibration. (For certain tests more than one set of QC check samples may be necessary in order to demonstrate capability for the full analyte list.)

13.2.1. Four aliquots of the QC check sample are analyzed using the same procedures used to analyze samples, including sample preparation.

13.2.2. Calculations and acceptance criteria for the QC check samples are given in the determinative SOPs. (CORP-GC-0001, CORP-MS-0001, 0002)

13.3. Training Qualification

The group/team leader has the responsibility to ensure that this procedure is performed by an analyst who has been properly trained in its use and has the required experience.

14. POLLUTION PREVENTION

Within the constraints of following the methodology in this SOP, use of organic solvents should be minimized.

15. WASTE MANAGEMENT

15.1. All waste will be disposed of in accordance with Federal, State and Local regulations. Where reasonably feasible, technological changes have been implemented to minimize the potential for pollution of the environment. Employees will abide by this method the policies in section 13 of the Corporate Safety Manual for "Waste Management and Pollution Prevention."

15.2. The following waste streams are produced when this method is carried out.

15.2.1. **Extracted aqueous samples contaminated with methylene chloride**. Samples are drained into the liquid-liquid separation unit located in extractions. This tank is then periodically rolled to the tank room where the DCM is emptied a larger tank using tubing attached to the bottom of the tank. The remaining water is neutralized with sodium bicarbonate, the pH verified and the water discharged to the sanitary sewer. The waste is disposed of as Methylene chloride contaminated waste.

15.2.2. Used sodium sulfate and glass wool or filter paper contaminated with methylene chloride/acetone or acetone/hexane from the extract drying step. These materials are disposed of in the solid waste and debris in a red container located in the extractions lab.

15.2.3. **Assorted flammable solvent waste from various rinses**. These wastes are put into the halogenated/non-halogenated 25 gallon solvent waste container located under the fume hood in extractions.

15.2.4. **Methylene chloride waste from various rinses:** These wastes are disposed of in the liquid-liquid separation unit.

15.2.5. **Hexane- Hexane waste:** These samples are to be disposed in the flammable waste.

15.2.6. **Waste Hexane in vials.** These vials are placed in the vial waste located in the GC prep laboratory.

15.2.7. **Waste Methylene Chloride sample vials**. These vials are placed in the vial waste located in the GC prep laboratory.

15.2.8. **Extracted solid samples contaminated with methylene chloride/acetone or acetone/hexane.** These materials are disposed of in the solid waste and debris in a red container located in the extractions lab.

15.2.9. Samples, standards, and all extraction materials contaminated with high levels (>50ppm) of PCB's must be segregated into their own waste stream.

PCB wastes are collected in one of three waste streams, solid PCB, liquid PCB and PCB vial waste.

16. REFERENCES

16.1. References

16.1.1. Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, SW846, 3rd Edition, Final Update III (December 1996). Sections 3500B, 3510C, 3520C, 3540C, 3550B, 3600C, 3610B, 3620B, 3640A, 3650B, 3660B, AND 3665A.

16.1.2. Corporate Quality Management Plan (QMP), current version.

16.1.3. STL Laboratory Quality Manual (LQM), current version.

16.2. Associated SOPs and Policies, latest version

16.2.1. QA Policy, QA-003
16.2.2. Glassware Washing, NC-QA-0014

16.2.3. Statistical Evaluation of Data and Development of Control Charts, NC-QA-0018

16.2.4. Method Detection Limits and Instrument Detection Limits, NC-QA-0021

16.2.5. Navy/Army SOP, NC-QA-0016

16.2.6. Hazardous Waste Management SOP, NC-HS-0001.

17. MISCELLANEOUS

17.1. Modifications from Reference method

17.1.1. Some surrogate spiking concentrations are modified from those recommended in SW-846, in order to make the concentrations more consistent with the calibration levels in the determinative methods.

17.1.2. Aqueous sample volumes may be determined by weight.

17.1.3. Spiking levels for method 608 have been reduced by a factor of ten to bring the levels within the normal calibration range of the instrument.

17.1.4. 10 g of soil is used for pH determination, rather than the 50 g suggested in the reference method. The volume of water is also adjusted to maintain the sample / water ratio specified in the method.

17.2. Modifications from previous revision

17.2.1. SOP change forms are on record in the Quality Assurance Department.

17.3. Facility Specific SOPs

Each facility shall attach a list of facility specific SOPs or approved attachments (if applicable) which are required to implement this SOP or which are used in conjunction with this SOP. If no facility specific SOPs or amendments are to be attached, a statement must be attached specifying that there are none.

17.3. Tables

Table 1
Liquid /Liquid Extraction Conditions

Determinative Method	Initial Ext. pH	Secondary Ext. pH
BNA: 8270C[1]	1-2	11-12
625	11-12	1-2
Pest/PCB: 8081A, 8082 & 608	5-9	None
Wisconsin DRO	2	
OPP: 8141A	as received	None
Hydrocarbons: 8015B	as received	None
PAH: 8310, & 610	as received	None

[1] If the laboratory has validated acid only 8270 extraction for the target compound list required then the base extraction step may be omitted. The required validation consists of a 4 replicate initial demonstration of capability and a method detection limit study. (See section 13). Additionally, either of the base or acid fractions of Method 8270 can be run first.

Table 2
Exchange Solvents and Final Volumes

Final Volumes and Exchange Solvents if no cleanup is used		
Type	Exchange Solvent for Analysis	Final Volume for Analysis in mL
Semivolatiles	N/A	2.0 mL
PCB	50mL Hexane	10.0 for solids 5.0 for H2O 2.0 for H2O**
Pesticides	50mL Hexane	10.0 for solids 5.0 for H2O
Pesticides/TCLP	50mL Hexane	3.0 mL
PAH by HPLC	4mL Acetonitrile	1.0 mL
BNA – SIM	N/A	2.0 mL - Solids & H2O
TPH	N/A	1.0
OPP	20mL Hexane/Acetone	2.0

*Requires high sensitivity mass spec tune (refer to NC-MS-0015 PAH by SIM)
** Michigan work requires a final volume of 2 mL.

Final Volumes and solvents if GPC cleanup is used CLP ONLY – SOLIDS ONLY			
Type	Solvent for GPC	Final Volume for GPC	Final Volume and solvent for Analysis
Semivolatiles	CH_2Cl_2	10 mL[1]	0.5 mL CH_2Cl_2 - OLM03.1
Semivolatiles	CH_2Cl_2	10 mL[1]	2.5 mL CH_2Cl_2 - OLM04.2
Pesticides	CH_2Cl_2	10 mL[1]	5 mL, Hexane

[1] Final volume for GPC may be 4 mL if a 2 mL sample loop is used

Final volumes and solvents if Florisil cleanup is used CLP ONLY			
Type	Solvent for Florisil	Final Volume for Florisil	Final Volume and solvent for Analysis
Pesticides	Hexane	10 mL (2 mL aliquot used)	2 mL, hexane

Final volumes and solvents if both GPC and Florisil cleanup are used CLP ONLY					
Type	Solvent for GPC	Final Volume for GPC	Solvent for Florisil	Final Volume for Florisil	Final volume for analysis
Pesticides	Methylene Chloride	10 mL	Hexane	5 mL (2 mL aliquot used)	2 mL, hexane

Note: Different final volumes may be necessary to meet special client reporting limit requirements.

.Table 3
Surrogate Spiking Solutions

Analyte Group	Surrogate Spike Solution ID	Volume (mL)
BNA	100/150 ppm BNA	0.2
BNA / SIM	100/150 ppm BNA	.2 / 0.02
PEST	0.2 ppm DCB/TCX	1.0
TPH	40ng C9	1.0
PCB	0.2 ppm DCB/TCX	1.0
PAH	1.0 ug/mL p-Terphenyl-d14 5.0 ug/mL Benzo(e)pyrene	1.0
OPP	10 ug/mL Triphenyl Phosphate	1.0

Table 4

Matrix Spike and LCS Solutions

Analyte Group	Matrix Spike Solution ID	Volume (mL)
BNA	100 ppm BNA All-Analyte Spike & Restek Spike	0.2
BNA / SIM	100 ppm BNA All-Analyte Spike & Restek Spike	0.2 / 0.02
PEST	Pest NPDES Spike	1.0
PEST TCLP	Pest TCLP Spike	1.0
PCB	10 ppm PCB Spike	1.0
PAH	See Spike List – Table 6	1.0
TPH	See Spike List – Table 6	1.0
OPP	See Spike List – Table 6	1.0

Table 5
Surrogate Spike Components

Type	Compounds	Solvent	Conc. (µg/mL)
BNA	2-Fluorobiphenyl	Methanol	100
	Nitrobenzene-d5		100
	p-Terphenyl-d14		100
	2-Fluorophenol		150
	Phenol-d6		150
	2,4,6-Tribromophenol		150
	1,2-Dichlorobenzene-d4		100
	2-Chlorophenol-d4		150
Pest/PCB	Decachlorobiphenyl	Methanol Acetone	0.2
	Tetrachloro-m-xylene		0.2
TPH	Nonane (C9)	Methanol	40.0
PAH	p-Terphenyl-d-14	CH3CN	1.0
	Benzo(e)pyrene		5.0
OPP	Triphenylphosphate	Acetone	10.0

Table 6
Matrix Spike Components

Type	Compounds	Solvent	Conc. (µg/mL)
TCL BNA	Acenaphthene	Methanol	100
	4-Chloro-3-Methylphenol		150
	2-Chlorophenol		150
	1,4-Dichlorobenzene		100
	2,4-Dinitrotoluene		100
	4-Nitrophenol		150

Table 6

Matrix Spike Components

Type	Compounds	Solvent	Conc. (µg/mL)
	N-Nitroso-Di-n-Propylamine		100
	Pentachlorophenol		150
	Phenol		150
	Pyrene		100
	1,2,4-Trichlorobenzene		100
BNA TCLP	1,4-Dichlorobenzene	Methanol	100
	2,4-Dinitrotoluene		100
	Hexachlorobenzene		100
	Hexachlorobutadiene		100
	Hexachloroethane		100
	2-Methylphenol		100
	3-Methylphenol		100
	4-Methylphenol		100
	Nitrobenzene		100
	Pentachlorophenol		100
	Pyridine		100
	2,4,5-Trichlorophenol		100
	2,4,6-Trichlorophenol		100
BNA NPDES		Methanol	
	Acenaphthene		100
	Acenaphthylene		100
	Anthracene		100
	Benzo(a)anthracene		100
	Benzo(b)fluoranthene	Methanol	100

Table 6

Matrix Spike Components

Type	Compounds	Solvent	Conc. (µg/mL)
	Benzo(k)fluoranthene		100
	Benzo(a)pyrene		100
	Benzo(ghi)perylene		100
	Benzyl butyl phthalate		100
	Bis(2-chloroethyl)ether		100
	Bis(2-chloroethoxy)methane		100
	Bis(2-ethylhexyl)phthalate		100
	Bis(2-chloroisopropyl)ether		100
	4-Bromophenyl phenyl ether		100
	2-Chloronaphthalene		100
	4-Chlorophenyl phenyl ether		100
	Chrysene		100
	Dibenzo(a,h)anthracene		100
	Di-n-butylphthalate		100
	1,3-Dichlorobenzene		100
	1,2-Dichlorobenzene		100
	1,4-Dichlorobenzene		100
	3,3'-Dichlorobenzidine		100
	Diethyl phthalate		100
	Dimethyl phthalate		100
	2,4-Dinitrotoluene		100
	2,6-Dinitrotoluene		100
	Di-n-octylphthalate		100
	Fluoranthene		100
	Fluorene		100

Table 6

Matrix Spike Components

Type	Compounds	Solvent	Conc. (µg/mL)
	Hexachlorobenzene		100
	Hexachlorobutadiene		100
	Hexachloroethane		100
	Indeno(1,2,3-cd)pyrene		100
	Isophorone		100
	Naphthalene		100
	Nitrobenzene		100
	N-Nitrosodi-n-propylamine		100
	Phenanthrene		100
	Pyrene		100
	1,2,4-Trichlorobenzene		100
	4-Chloro-3-methylphenol		100
	2-Chlorophenol		100
	2,4-Dichlorophenol		100
	2,4-Dimethylphenol		100
	2,4-Dinitrophenol		100
	2-Methyl-4,6-dinitrophenol		100
	2-Nitrophenol		100
	4-Nitrophenol		100
	Pentachlorophenol		100
	Phenol		100
	2,4,6-Trichlorophenol		100
	Acetophenone		100
	Atrazine		100
	Caprolactum		100

Table 6

Matrix Spike Components

Type	Compounds	Solvent	Conc. (µg/mL)
	Benzaldehyde		100
	1,1′-Biphenyl		100
	Safrole		100
	1,4-Dioxane		100
	Pronamide		100
	p-Chlorobenzilate		100
	Phenacetin		100
	Ethyl methanesulfonate		100
	2-Picoline		100
	Phorate		100
	Quinoline		100
Pest TCLP	Heptachlor	Methanol Acetone	0.5
	Heptachlor epoxide		0.5
	Lindane		0.5
	Endrin		0.5
	Methoxychlor		1.0
Pest NPDES /Pest	Aldrin	Methanol Acetone	1.0
	alpha-BHC		1.0
	beta-BHC		1.0
	delta-BHC		1.0
	gamma-BHC (Lindane)		1.0
	4,4'-DDD		1.0
	4,4'-DDE		1.0

Table 6			
Matrix Spike Components			
Type	Compounds	Solvent	Conc. (µg/mL)
	4,4'-DDT		1.0
	Dieldrin		1.0
	alpha-Endosulfan		1.0
	beta-Endosulfan		1.0
	Endosulfan Sulfate		1.0
	Endrin		1.0
	Heptachlor		1.0
	Heptachlor Epoxide		1.0

Diesel Range Organics (8015B) Spike	
Compound	**Final Concentration**
n-decane	50 µg/ml
n-dodecane	50 µg/ml
n-tetradecane	50 µg/ml
n-hexadecane	50 µg/ml
n-octadecane	50 µg/ml
n-eicosane	50 µg/ml
n-docosane	50 µg/ml
n-tetracosane	50 µg/ml
n-hexacosane	50 µg/ml
n-octacosane	50 µg/ml

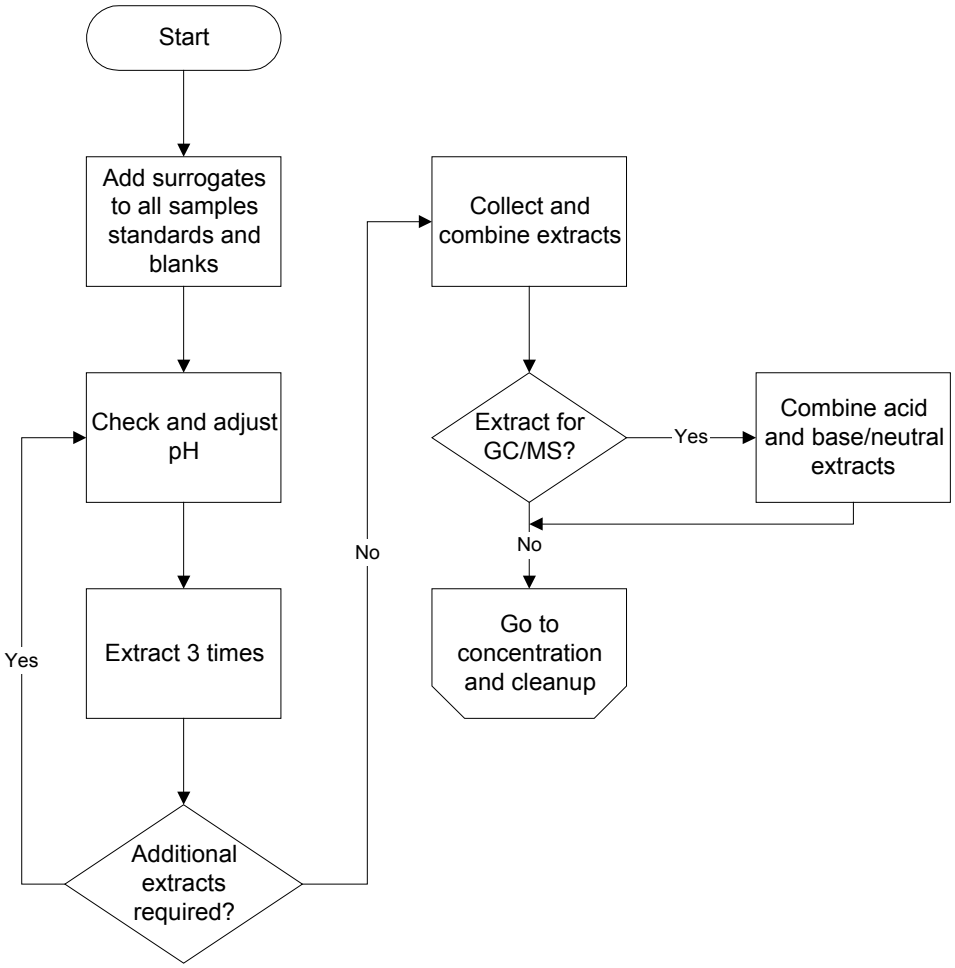
Organophorphorous Pesticides (8141A)	
Compound	**Final Concentration**
dimethoate	20 µg/mL
disulfoton	20 µg/mL
famphur	20 µg/mL
methyl parathion	20 µg/mL

parathion (ethyl)	20 µg/mL
phorate	20 µg/mL
sulfotepp	20 µg/mL
thionazin	20 µg/mL
o,o,o-triethyl phosphorothioate	20 µg/mL
triphenylphosphate (surrogate)	20 µg/mL

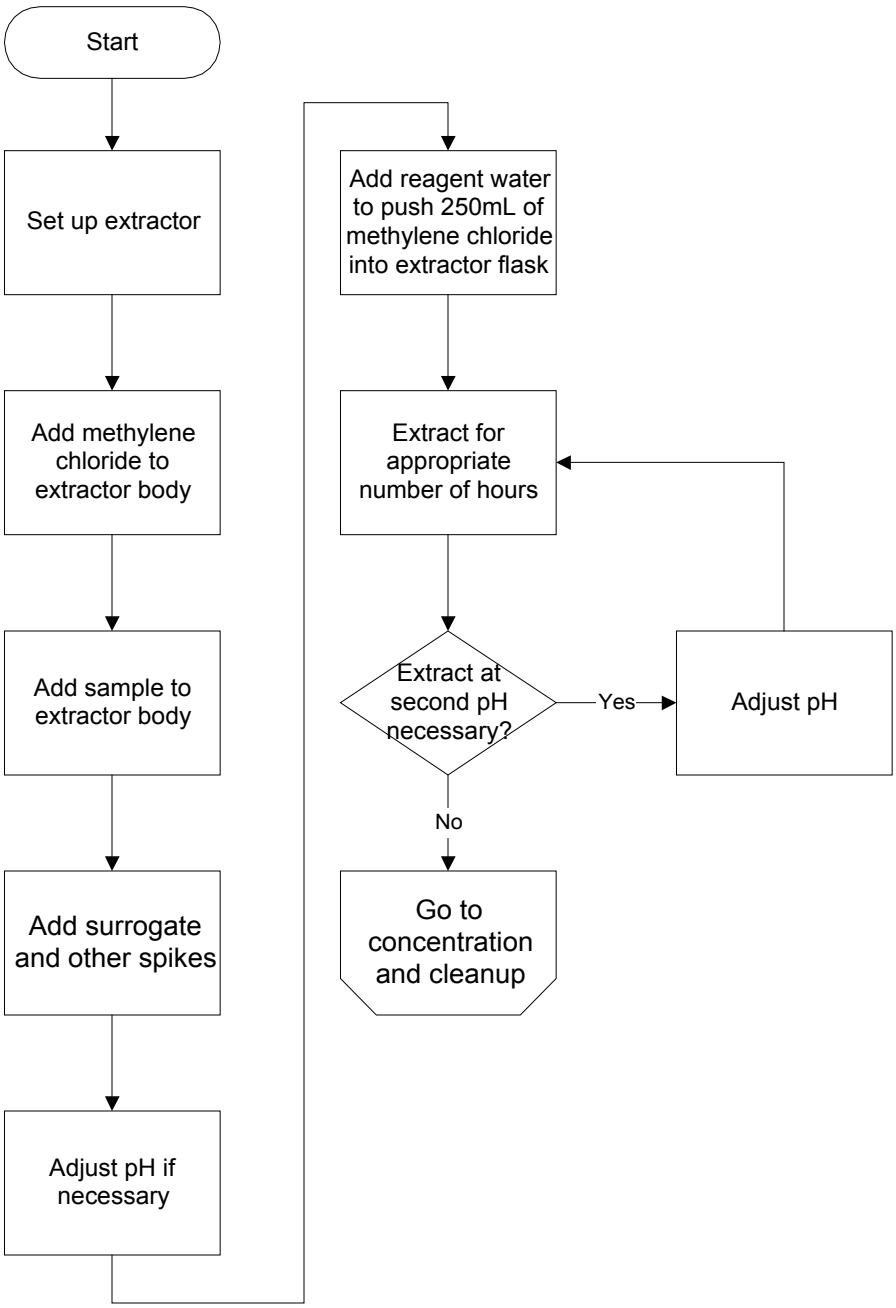
Polynuclear Aromatic Hydrocarbons (8310)	
Compound	**Final Concentration**
Acenaphthylene	10 µg/mL
Carbazole	10 µg/mL
Naphthalene	10 µg/mL
1-Methylnaphthalene	10 µg/mL
2-Methylnaphthalene	10 µg/mL
Acenaphthene	10 µg/mL
Fluorene	2 µg/mL
Phenanthrene	2 µg/mL
Anthracene	2 µg/mL
Fluoranthene	2 µg/mL
Pyrene	2 µg/mL
Benzo(a)anthracene	2 µg/mL
Chrysene	2 µg/mL
Benzo(a)pyrene	2 µg/mL
Benzo(k)fluoranthene	2 µg/mL
Benzo(a)pyrenek)fluoranthene	2 µg/mL
Dibenzo(a,h)anthracene	2 µg/mL
Benzo(g,h,I)perylene	2 µg/mL
Indeno(1,2,3-cd)pyrene	2 µg/mL

17.5. Flow diagrams

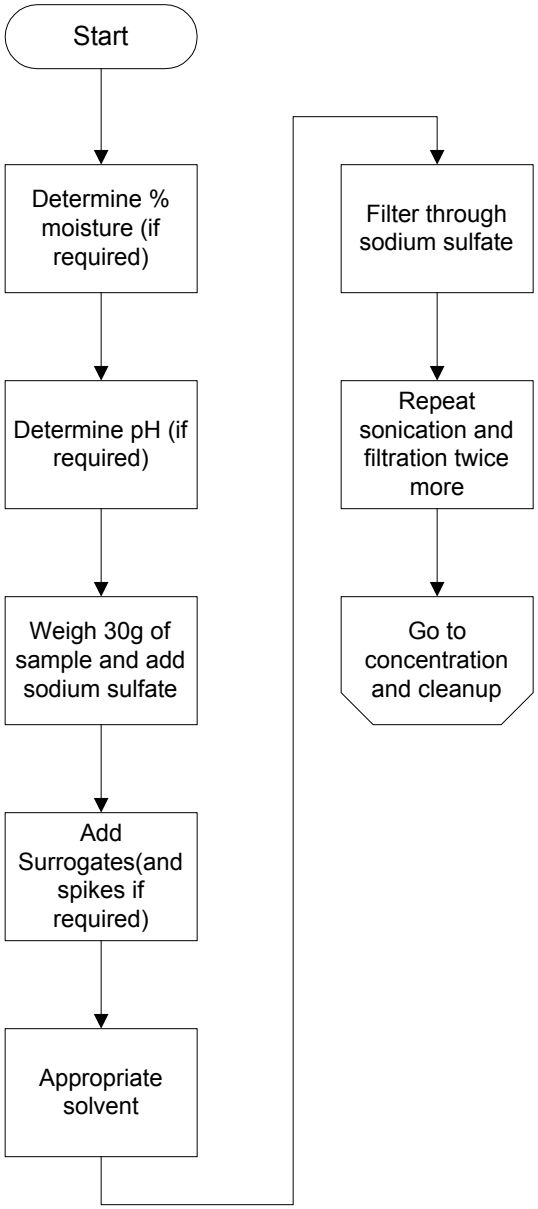
17.5.1. Separatory funnel extraction



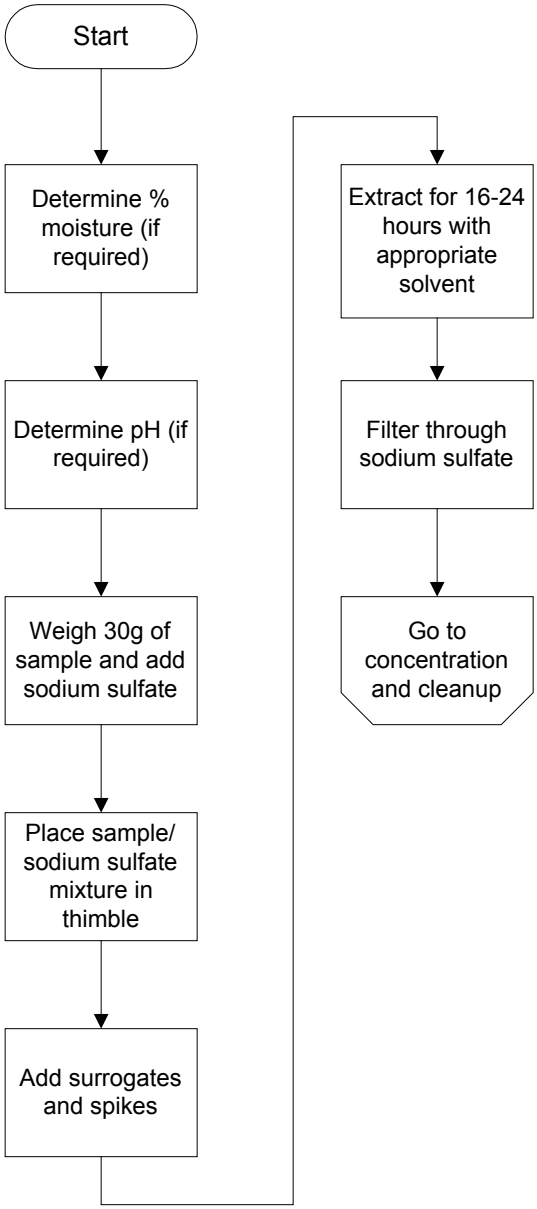
17.5.2. Continuous liquid/liquid extraction


Start
Set up extractor
Add methylene chloride to extractor body
Add sample to extractor body
Add surrogate and other spikes
Adjust pH if necessary
Add reagent water to push 250mL of methylene chloride into extractor flask
Extract for appropriate number of hours
Extract at second pH necessary?
Yes
Adjust pH
No
Go to concentration and cleanup

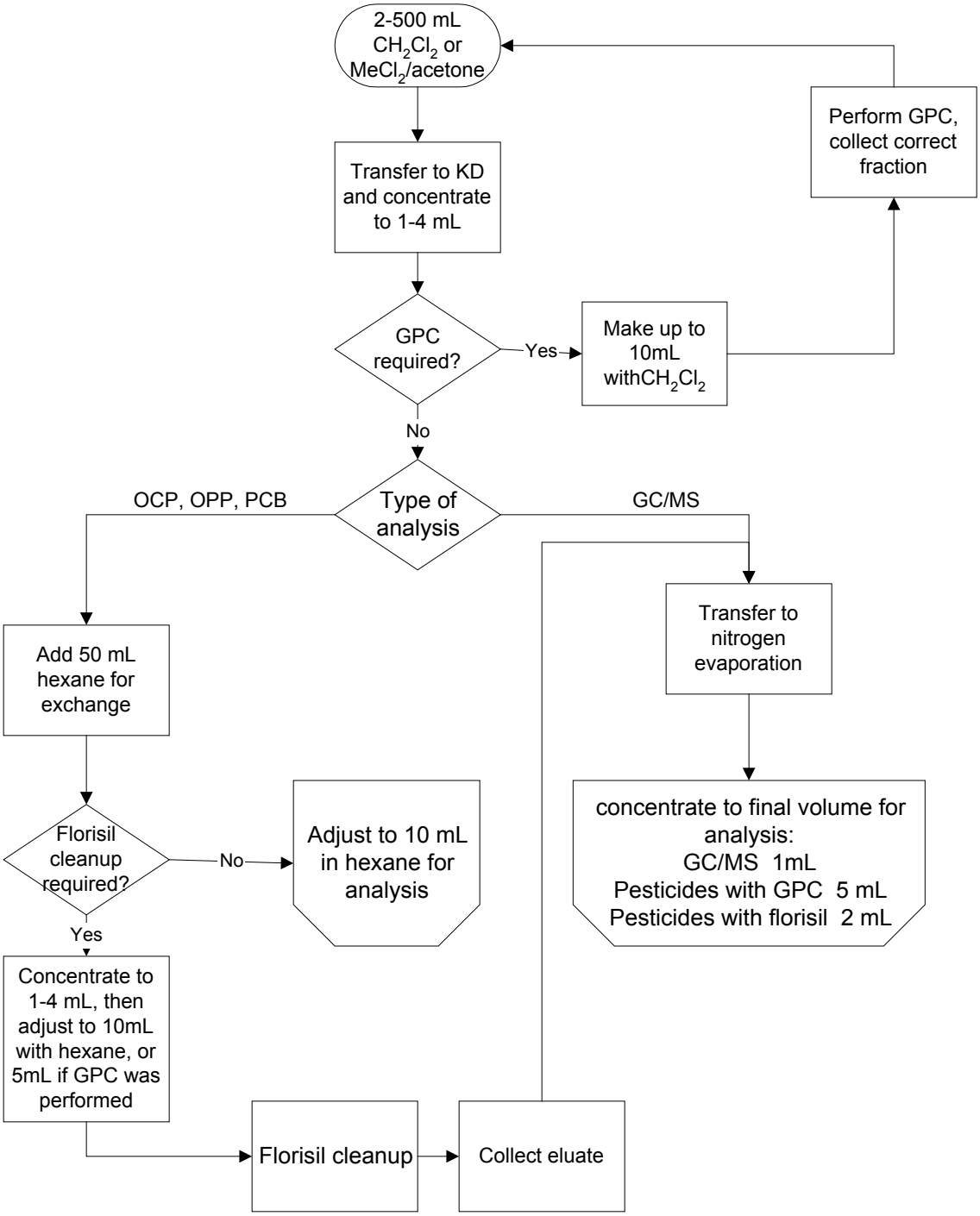
17.5.3. Sonication Extraction



17.5.4. Soxhlet extraction



17.5.5. Concentration and cleanup



1. SCOPE AND APPLICATION

1.1. This method is applicable to the extraction of chlorinated herbicides in waters, solids, oils, and TCLP extracts. Appropriate compounds for extraction by this method are listed in CORP-GC-0001, Appendix D, Gas Chromatography of Phenoxy Acid Herbicides based on Method 8151A.

2. SUMMARY OF METHOD

2.1. This method is based on SW846 method 8151A. Aqueous samples are hydrolyzed if esters and acids are to be determined, then washed with methylene chloride by a separatory funnel extraction. After acidifying the sample the free acids are extracted into diethyl ether. Solids are extracted into methylene chloride/ acetone by sonication. If esters and acids are to be determined, the extract is hydrolyzed and extracted into diethyl ether. For both soils and aqueous samples, the free acid herbicides in the ether extract are esterified. The final volume is adjusted to prepare the extract for gas chromatography.

3. DEFINITIONS

3.1. Refer to section 3 of the main body of this SOP.

4. INTERFERENCES

4.1. Refer to section 4 of the main body of this SOP.

5. SAFETY

5.1. Refer to section 5 of the main body this SOP for basic safety information.

5.2. DIAZOMETHANE is an extremely toxic gas with an explosion potential. Since the explosion potential is catalyzed by imperfections in glass, generation of diazomethane must be carried out in glassware free of scratches, cracks, chips and which does not have ground glass joints. Solutions of diazomethane will be kept at temperatures below 90°C. Diazomethane must be generated and handled in a fume hood.

5.3. Diethyl ether must be free of peroxides as demonstrated by EM (or equivalent) Quant test strips. This test can be done every time the ether is used or once per week if the bottle is marked with the test date(s).

5.4. Concentrated potassium hydroxide solution is highly caustic.

Material (1)	Hazards	Exposure Limit (2)	Signs and symptoms of exposure

Nitric Acid	Oxidizer Poison	2 ppm-TWA 4 ppm-STEL	Nitric acid is extremely hazardous; it is corrosive, reactive, an oxidizer, and a poison. Inhalation of vapors can cause breathing difficulties and lead to pneumonia and pulmonary edema, which may be fatal. Other symptoms may include coughing, choking, and irritation of the nose, throat, and respiratory tract. Can cause redness, pain, and severe skin burns. Concentrated solutions cause deep ulcers and stain skin a yellow or yellow-brown color. Vapors are irritating and may cause damage to the eyes. Contact may cause severe burns and permanent eye damage.
Ethyl Ether	Flammable Irritant Peroxide Former	400 ppm-TWA	General anesthesia by inhalation can occur. Continued exposure may lead to respiratory failure or death. Early symptoms include irritation of nose and throat, vomiting, and irregular respiration, followed by dizziness, drowsiness, and unconsciousness. May cause irritation, redness and pain to the eyes. Irritating to the skin and mucous membranes by drying effect. Can cause dermatitis on prolonged exposure. May be absorbed through skin. **May form explosive peroxides on long standing or after exposure to air or light. This material must be disposed of within six months.**
1 – Always add acid to water to prevent violent reactions.			
2 – Exposure limit refers to the OSHA regulatory exposure limit.			

6. EQUIPMENT AND SUPPLIES

6.1. Refer to Section 6 of the main body of this SOP for basic extraction equipment and supplies. Additional equipment and supplies needed for this procedure are listed below.

6.2. Diazomethane generation apparatus

7. REAGENTS AND STANDARDS

7.1. Reagents are listed in Section 7 of the main body of this SOP. Additional reagents and standards needed for this procedure are listed below.

7.2. Reagents

7.2.1. Potassium hydroxide solution, 37% aqueous solution, (w/v): Dissolve 37 g of potassium hydroxide pellets in reagent water and dilute to 100 mL. **Caution:** Considerable heat will be generated. Other volumes of solution may be made up as convenient.

7.2.2. Toluene, reagent grade

7.2.3. 2-(2-Ethoxyethoxy)ethanol, trade name Carbitol, 98%+purity

7.2.4. Diazald, 99% purity

7.2.5. Sodium sulfate, Na_2SO_4, Anhydrous, granular, acidified: Heat sodium sulfate in a shallow tray at 400°C for a minimum of 4 hours to remove phthalates and other interfering organic substances. In a large beaker, acidify by slurrying 500 g sodium sulfate with just enough diethyl ether to cover. Add 20 mL of concentrated sulfuric acid and mix thoroughly. Place the mixture on a steam bath in a hood to evaporate the ether, or allow the ether to evaporate overnight. Larger or smaller batches of acidified sodium sulfate may be prepared using the reagents in the same proportions.

7.2.6. Sodium Chloride, NaCl

7.2.7. BF3-Methanol, Boron trifluoride-MeOH, lab use only

7.2.8. Diethyl ether, reagent grade.

7.2.9. Trimethylsilydiaomethane

7.2.10. Methanol, reagent grade.

7.2.11. Silica gel

7.2.12. 2% methanolic KOH, semi-conductor grade

7.3. Standards

7.3.1. Surrogate Standard

7.3.1.1. See Table A3.

7.3.2. Matrix Spike and LCS standard

7.3.3. See Table A4.

8. SAMPLE COLLECTION PRESERVATION AND STORAGE

8.1. Sample collection and storage is described in Section 8 of the main body of this SOP.

9. QUALITY CONTROL

9.1. Refer to Section 9 of the main body of this SOP for Quality control procedures.

10. CALIBRATION AND STANDARDIZATION

10.1. Not applicable

11. PROCEDURE

11.1. Preparation of Aqueous Samples

11.1.1. Weigh the sample bottle and pour approximately 500 ml (100 mL for TCLP leachates) into a 1 liter wide-mouth amber jar. Reweigh the bottle and record the sample volume on the benchsheet, assuming a density of 1.0. Alternatively, measure 500 ml in a graduated cylinder. If less than 500 mL was used, reagent water may be added to make the volume up to 500 mL. Note: Aqueous samples must be determined volumetrically for Ohio VAP samples.

11.1.2. Spike each sample blank, LCS and MS with 1.0 mL of DCAA surrogate solution. Spike matrix spikes and LCS with 1 mL of herbicide matrix spiking solution. (Refer to tables A1 and A2)

11.1.3. Add 60-80 g of NaCl to the sample and shake to dissolve the salt.

11.1.4. Hydrolysis

11.1.4.1. Use this step only if herbicide esters in addition to herbicide acids are to be determined. This is normally the case. If the herbicide esters are not to be determined, omit this step and go to 11.4.1.8.

11.1.4.2. Add 3 mL of 10N NaOH to the sample, seal and shake. Check the pH of the sample with pH paper. If the pH of the sample is not $\geq$12 adjust to $\geq$12 by adding more NaOH. Let the sample sit at room temperature for 2 hours to complete the hydrolysis.

11.1.4.3. Add 300 mL of methylene chloride to the amber jar.

11.1.4.4. Prior to placing samples in tumbler, the samples should be shaken or rotated vigorously for 2 minutes, venting as necessary. Place the samples in tumbler and allow them to tumble for one (1) hour. Allow the organic layer to separate from the aqueous layer. If an emulsion layer greater than one third of the solvent layer forms, use mechanical techniques to complete the phase separation. Suggested techniques are stirring, filtration through glass wool and centrifugation.

11.1.4.5. Pour contents of amber jar into a pre-rinsed teflon sep funnel.

11.1.4.6. Discard the **methylene chloride** phase.

11.1.4.7. Add 6 mL of cold (4°C) 1:1 sulfuric acid to the sample. Seal, and shake to mix. Check the pH of the sample with pH paper. If the pH is not $\leq$ 2, and more acid to adjust the pH to $\leq$ 2.

Caution: Addition of acid may cause heat and / or pressure build up.

11.1.4.8. Add 100 mL diethyl ether to the sample and extract by shaking or rotating vigorously for 10 minutes, venting as necessary. Allow the organic layer to separate from the aqueous layer. If an emulsion layer greater than one third of the solvent layer forms, use mechanical techniques to complete the phase separation. Suggested techniques are stirring, filtration through glass wool and centrifugation.

11.1.4.9. Drain the aqueous layer into a clean flask or beaker. Collect the ether phase in a clean flask or bottle containing approximately 10g of acidified anhydrous sodium sulfate.

11.1.4.10. Return the aqueous phase to the separatory funnel, add 100 mL diethyl ether and repeat the extraction procedure a second time, combining the ether extracts. Repeat the extraction a third time with 100 mL diethyl ether. Discard the aqueous phase after the third extraction.

11.1.4.11. Allow the extract to remain in contact with the sodium sulfate for at least 2 hours, shaking periodically. (May be left overnight). The drying step is critical: if the sodium sulfate solidifies in a cake, add a few additional grams of acidified sodium sulfate. The amount of sodium sulfate is sufficient if some free flowing crystals are visible when the flask or bottle is swirled or shaken.

11.1.4.12. Proceed to Section 11.5, Concentration.

11.2. Extraction of soil and sediment samples

11.2.1. Decant and discard any water layer on a sediment/soil sample. Record and document if a water layer was discarded on the benchsheet. Homogenize the sample by mixing it thoroughly in the container. If this is not possible place the sample in clean beaker and homogenize. Upon completion of homogenization in beaker return sample to original container. Discard foreign objects such as sticks, leaves and rocks, unless extraction of this material is required by client. If the sample consists primarily of foreign materials consult with the client (via the Project Manager or Administrator).

11.2.2. Weigh 50.0 g of moist solid sample into a clean glass jar. Use 50 g of sodium sulfate for the Method Blank and the LCS. Acidify the sample with 5 mL of concentrated HCl.

11.2.3. There should be a small amount of liquid phase. If not, add reagent water until there is. Stir well with a spatula. (Note: This is not necessary for the method blank or LCS)

11.2.4. After 15 minutes, stir with a spatula and check the pH of the liquid phase. Add more acid if necessary to bring the pH to <2, repeating the stirring and standing time after each acid addition. (Note: The pH of the method blank and LCS are not determined.)

11.2.5. Add 60 g of acidified sodium sulfate and mix well. The sample should be free flowing. If not, add more sodium sulfate.

11.2.6. Spike each sample blank, LCS and MS with 1.0 mL of DCAA surrogate solution. Spike matrix spikes and LCS with 1 mL of herbicide matrix spiking solution. (Refer to tables A1 and A2)

11.2.7. Add a minimum of 100 mL of 1:1 methylene chloride:acetone to the beaker or 100 mL of methylene chloride for long list (dinoseb).

11.2.8. Place the bottom surface of the appropriate disrupter horn tip approximately ½ inch below the surface of the solvent, but above the sediment layer.

11.2.9. Sonicate for 3 minutes, making sure the entire sample is agitated.

11.2.10. Loosely plug the stem of a 75 mm x 75 mm glass funnel with glass wool and/or line the funnel with filter paper. Add 10-20 g of anhydrous sodium sulfate to the funnel cup.

11.2.11. Place the prepared funnel on a collection apparatus. If the herbicide esters are *not* to be determined, the collection apparatus is a bottle or flask containing approximately 10g of anhydrous acidified sodium sulfate. If the

herbicide esters *are* to be determined, (normally the case) the collection apparatus is glassware suitable for the hydrolysis step, typically a KD flask or Turbovap tube.

11.2.12. Decant and filter extracts through the prepared funnel into the collection apparatus.

11.2.13. Repeat the extraction two more times with additional 100 mL minimum portions of the appropriate solvent each time. Decant off extraction solvent after each sonication. On the final sonication pour the entire sample (sediment and solvent) into the funnel and rinse with an additional 10 mL-20 mL of the methylene chloride/acetone.

Note: Alternatively, the three extracts may be collected together and then filtered through the sodium sulfate.

11.2.14. If the herbicide esters are not to be determined, dry the extract as described in Section 11.4 or go to cleanup, Section 11.3. If the herbicide esters are to be determined (normally the case) proceed to Section 28.2.15

11.2.15. Add 5 mL of 37% aqueous potassium hydroxide and 30 mL of water to the extract. Check the pH with pH paper. If the pH is not $\geq$12, adjust with additional KOH.

11.2.16. Heat on a water bath at 60-65°C for 2 hours. Allow to cool. Higher temperatures, up to 90°C, may be used if needed to remove the ether layer within 2 hours.

11.2.17. Transfer the solution to a separatory funnel and extract three times with 100 mL portions of methylene chloride. **Discard the methylene chloride phase.** The aqueous solution contains the herbicides.

11.2.18. Adjust the pH of the solution to $\leq$2 with 1:1 sulfuric acid.

11.2.19. Extract three times with 60 mL diethyl ether.

11.2.20. Proceed to Section 11.3, Cleanup, if required, or Section 11.4, Extract drying.

11.3. Cleanup

11.3.1. This cleanup step may be necessary if the procedure for determining the herbicide acids only is being followed. (See Section 28.2.14) It is not normally required if the acids and esters

are being determined. (The usual case.) If cleanup is not required, proceed to Section 28.4, Extract drying.

11.3.2. Prepare 45 mL of basic extraction fluid by mixing 30 mL of reagent water with 15 mL of 37% KOH. Use three 15 mL portions of this fluid to partition the extract from section 28.2.12 or 28.2.20, using a small separatory funnel. **Discard the organic phase.**

11.3.3. Adjust the pH of the solution to $\leq$2 with cold (4°C) sulfuric acid. (1:1). Extract once with 40 mL diethyl ether and twice with 20 mL diethyl ether.

Caution: Addition of acid may cause heat and / or pressure build up.

11.4. Extract drying

11.4.1. Pour the extracts through a funnel containing acidified sodium sulfate into a flask or bottle containing approximately 10 g acidified sodium sulfate. Rinse the funnel with a little extra diethyl ether.

11.4.2. Allow the extract to remain in contact with the sodium sulfate for at least 2 hours, shaking periodically. (May be left overnight). The drying step is critical: if the sodium sulfate solidifies in a cake, add a few additional grams of acidified sodium sulfate. The amount of sodium sulfate is sufficient if some free flowing crystals are visible when the flask or bottle is swirled or shaken. Proceed to Section 28.5, concentration.

11.5. Concentration

11.5.1. Transfer the ether extract into a Turbovap concentrator tube or a 500 mL K-D flask **equipped with a 10 mL concentrator tube. Use** a stirring rod to crush the caked sodium sulfate during transfer. Rinse the flask or bottle with 20-30 mL ether to complete transfer.

11.5.2. Attach a three ball Snyder column to the K-D apparatus, prewet the column with a few mL of ether from the top, and place the apparatus on a water bath at approximately 60°C. At the proper rate of distillation, the balls of the column will chatter, but the chambers will not flood. When the apparent volume reaches 2 mL, remove from the water bath and allow to completely cool.

11.5.3. For TCLP extracts only, add 4 mL of toluene to the K-D (buffer reacts with diazald solution used in esterification).

11.5.4. Remove TCLP extracts at approximately 2 mL when boiling slows and only toluene is remaining. Cool and cap in CT.

11.5.5. Carefully disassemble the concentrator tube and rinse the lower glass joint with a small amount of diethyl ether.

11.5.6. The extract is now ready for esterification by the Diazomethane Bubbler Method (Section 11.7) or the TCLP esterification by Boron Triflouride Method (Section 11.8).

11.6. Esterification (Bubbler Method)

11.6.1. Assemble the diazomethane apparatus (see figure below) in a hood. Add 25-30 mL of diethyl ether to tube 1. Add 1.5 mL 37% KOH, 1 mL Carbitol, and 1 mL of ether and 3-4 g of diazald to tube 2.

11.6.2. Place the tip of the disposable pipette into the vial containing the first sample extract. Apply nitrogen flow (approx. 10 mL/min) to bubble diazomethane through the sample extract for about 4-5 minutes. Replace the disposable pipette and place the tip into the vial containing the second extract. Replace Tube 2 solution after second extract.

11.6.3. Allow the extracts to stand for 20 minutes, then add approximately 0.2 g of silica gel to each extract. Allow to stand for an additional 20 minutes.

11.6.4. Adjust the volume to 10 mL with hexane. The sample is now ready for gas chromatography.

11.6.5. A routine 10X dilution occurs on final extracts for all samples. Due to a QuantIMS limitation, the dilution factor field in QuantIMS cannot be used when a dilution is routine, because the dilution factor is automatically applied to all reference values creating reporting problems. For the herbicide analysis, the extract volume will be 10mL and an aliquot at 10X dilution will be analyzed. The final extract volume recorded on the laboratory bench sheet will be recorded as 100mL to avoid using the dilution factor field in QuantIMS.

11.7. Exterification by Boron trifluoride (TCLP extracts only).

11.7.1. To the concentrator tube with the extract, add 2 mL of Boron trifluoride. Place a two-ball micro-Snyder column on the concentrator tube and place in the Hot-Blok water bath adjusted to 35-40°C for 60 minutes. Remove and let cool for approximately ten minutes.

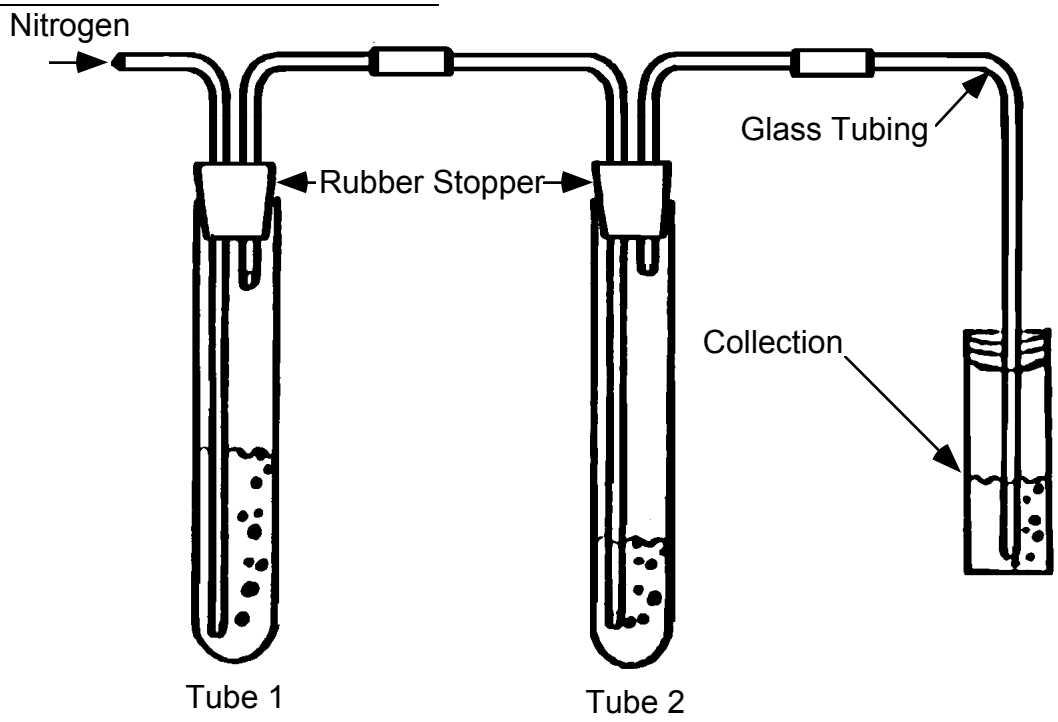
11.7.2. With a 10 mL graduated disposable 5-3/4" pipette 4.5 mL of 5% neutral sodium sulfate and place it in the concentrator tube. Seal with a tight fitting ground glass stopper. Vortex the mixture for one minute. Let stand for ten minutes to settle. With a 5-3/4" disposable pipette, withdraw the bottom aqueous layer into a 16 x 100 culture tube for proper disposal.

11.7.3. Prepare a clean up column in a 5-3/4" disposable pipette by placing a small amount of glass wool in the narrow end of the pipette and add about ½ inch – 1 inch of florisil and sodium sulfate each. Leave about a 1 inch gap at the top. Place the extract in the clean-up column and gently force it through by using a pipette bulb into a small test tube. **Care should be taken to avoid channeling.** Rinse the concentrator tube with 1-2 mL of toluene. Transfer the column rinsate into the test tube. Rinse the column with additional toluene. There should be approximately 4 mL collected in the test tube. Bring the final volume to 10 mL with toluene by visually comparing it to a calibrated collection tube.

Note: It is critical that all toluene is retained and no water should enter the column.

11.8 Esterification by Trimethylsilydiazomethane

11.8.2 Exchange the extract into Hexane and concentrate to 2.0 mls. 200 uL of Methanol is added to the extract then 100 uL of the trimethylsilyldiazomethane solution. The extract then turns a yellow colour. If this does not occur, then an additional 100 uL aliquot is added until the yellow persists. The extract then sits for 1 hour at room temperature to allow the methylation reaction to proceed. After 1 hour, the reaction is halted and the diazomethane removed by the addition of silicic acid. The extract is then brought up to a final volume of 10.0 mls with Hexane and submitted for analysis.



12. DATA ANALYSIS AND CALCULATIONS

12.1. Not applicable

13. METHOD PERFORMANCE

13.1. Refer to CORP-GC-0001 for details of method performance.

14. POLLUTION PREVENTION

14.1. Refer to Section 14 of the main body of this SOP.

15. WASTE MANAGEMENT

15.1. Refer to Section 15 of the main body of this SOP.

15.2. The following waste streams are produced when this method is carried out.

15.2.1. **Aqueous acidic waste.** These wastes are disposed of in the liquid-liquid separation unit

15.2.2. **Non-hazardous sodium sulfate**. Non hazardous substances can be disposed of in the regular trash.

16. REFERENCES

16.1. SW846, Test Methods for Evaluating Solid Waste, Third Edition, Update III, December 1996, Chlorinated Herbicides, Method 8151A.

17. MISCELLANEOUS

17.1. Modifications from Reference Method

17.1.1. Directions to add sufficient reagent water to the soil sample so that the pH can be measured have been added (Section 11.5.2)

17.1.2. The bubbler esterification method uses methanolic KOH in place of the aqueous KOH / carbitol mixture recommended in method 8150B. This has been found to provide a more effective and reliable esterification.

17.2. Modifications from previous revisions

17.2.1. References have been updated

17.3. Tables

Table A1
Herbicide Surrogate Spiking Solutions

Analyte Group	Surrogate Spike Solution ID	Volume (mL)
Herbicides	Herbicides Water	1.0
Herbicides	Herbicides Soil	1.0

Table A2
Herbicide Matrix Spike and LCS Solutions

Analyte Group	Matrix Spike Solution ID	Volume (mL)
Herbicides	Herbicides MS-Soil	1.0
Herbicides	Herbicides MS-Water	1.0

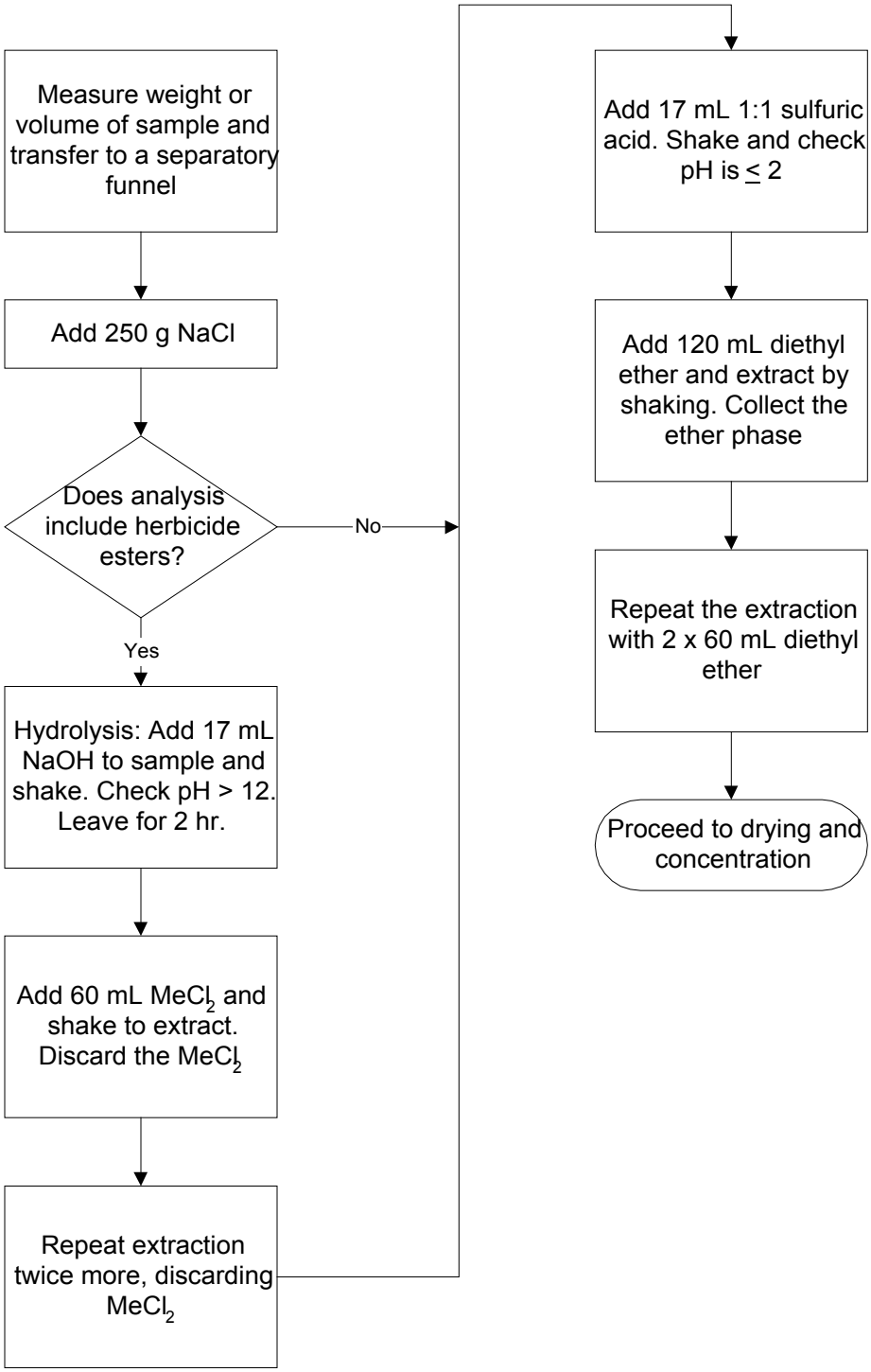
Table A3 Herbicide Surrogate Spike Components			
Type	Compounds[1]	Solvent	Conc. (ug/mL)
Herbicides WS	2,4-DCAA	Acetone	2
Herbicides SS	2,4-DCAA	Acetone Methanol	20

[1]The surrogate is spiked as the free acid

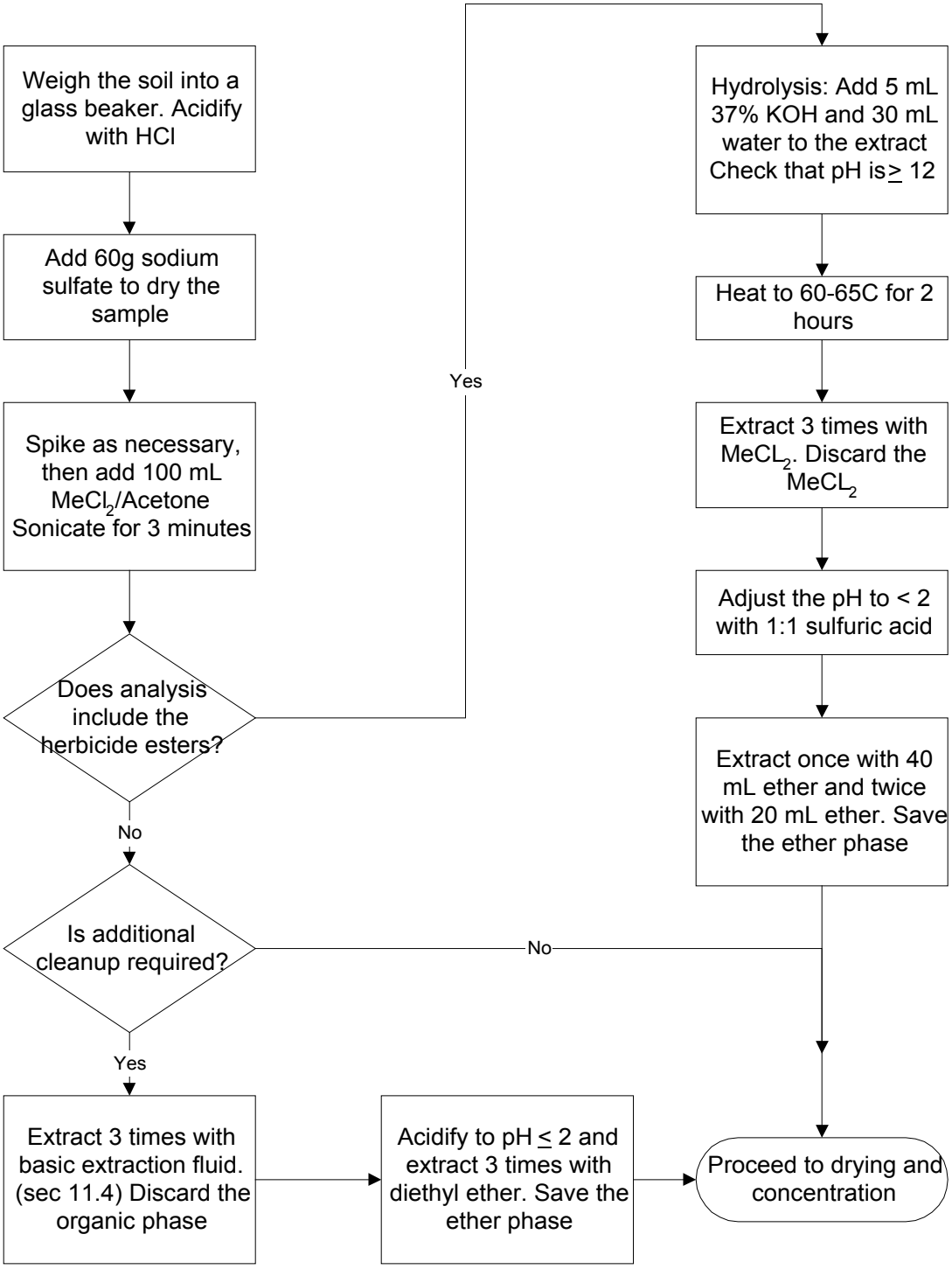
Table A4 Herbicide Matrix Spike Components				
Type	Compounds[1]	Compounds[1] Solvent	Water/Soil Conc. (ug/mL)	TCLP only Conc. (ug/mL)
Herbicides MS	2,4-D	Methanol	16	2
	2,4-DB		16	2
	2,4,5-TP (Silvex)		4	0.5
	Dalapon		8	1
	Dicamba		8	1
	Dichloroprop		16	1
	Dinoseb		2.5	0.3
	2,4,5-T		4	0.5
	MCPA		1600	
	MCPP		1600	
	Pentachlorophenol		2	

[1]The herbicide spiking solution contains the herbicides as the free acids.

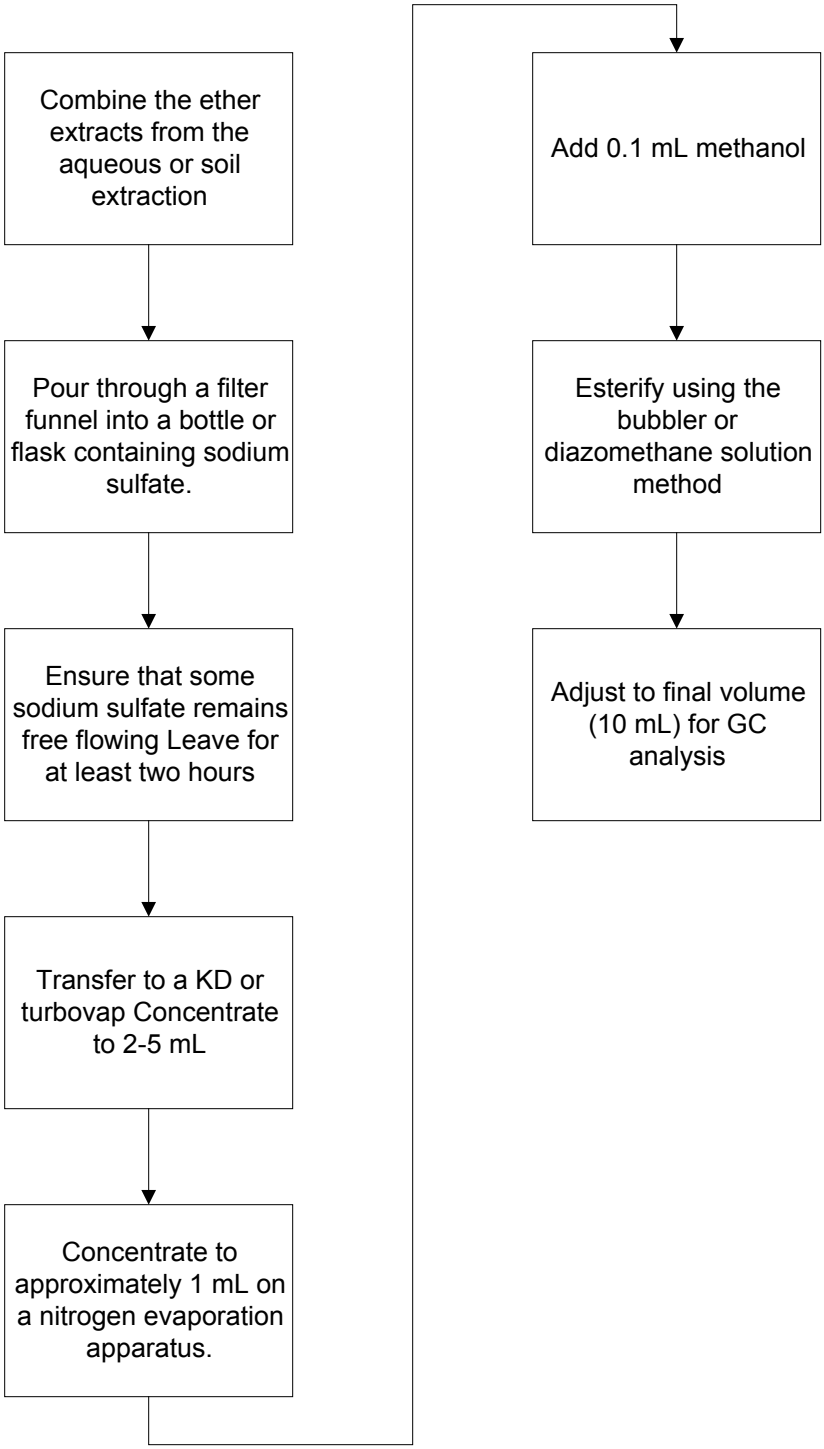
Extraction of Aqueous Samples



Extraction of Soils and Sediments



Drying, Concentration and Esterification



Appendix A:

Standard Operating Procedures (SOPs)

List of Standard Operating Procedures (SOPs)
Included in this Appendix

1. Soil Sampling 1
2. Water Level and Well Depth Measurements 3
3. Groundwater Sampling 7
4. Field Equipment Decontamination 9
5. Field Logbook 15
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SOP 1

SOIL SAMPLING

1.0 Scope and Application

The purpose of this standard operating procedure is to delineate protocols for sampling surface and subsurface soils. Soil samples give an indication of the area and depth of site contamination, so a representative sample is very important.

2.0 Materials

a. Stainless steel spoon, trowel, knife, spatula, (as needed)
b. Split-spoon, Shelby tube, or core barrel sampler
c. Bucket auger or push tube sampler
d. Drill rig and associated equipment
e. Stainless steel bowl
f. PPE as required by the HASP

3.0 Procedure

3.1 Surficial Soil Samples

a. Don PPE. Remove vegetative mat. Collect a sample from under the vegetative mat with a stainless steel trowel, push tube sampler, or bucket auger.
b. If a representative sample is desired over the depth of a shallow hole or if several shallow samples are to be taken to represent an area, composite as follows:
   i. As each sample is collected, place a standard volume in a stainless steel bowl.
   ii. After all samples from each hole or area are in the bucket, homogenize the sample thoroughly with a decontaminated stainless steel spoon, trowel or spatula.
c. If no compositing is to occur, place sample directly into the sample jars.
d. Place the leftover soil in the auger borings and holes left by sampling. If necessary, add clean sand to bring the subsampling areas back to original grade. Replace the vegetative mat over the disturbed areas.
e. Samples for VOCs will not be composited. A separate sample will be taken from a central location of the area being composited and transferred directly from the sampler to the sample container.
f. Preserve samples as required.
g. Decon sampling implements according to the Decontamination SOP

3.2 Subsurface Samples

a. Don PPE. Collect split-spoon, core barrel, or Shelby Tube samples during drilling.
b. Upon opening sampler, or extruding sample, immediately screen soil for volatile organic compounds using either a PID or FID. If sampling for VOCs, determine the area of highest concentration, use a stainless steel knife, trowel, or lab spatula to sample this area.
c. Log the sample in the field notebook, while it is still in the sampler.
d. Transfer the remaining sample into a decontaminated stainless steel bowl. Mix thoroughly with a decontaminated stainless steel spoon or trowel.
e. Place the sample into the required number of sample jars.
f. Preserve samples as required, if bottles not already preserved.
g. Discard any remaining sample into the drums being used for collection of cuttings
h. Decon sampling implements according to Decontamination SOP.
i. All borings will be abandoned according to local regulations or converted into monitoring wells.

NOTES: If sample recoveries are poor, it may be necessary to composite samples before placing them in jars. In this case, the procedure will be the same, except that two split-spoon samples will be mixed together. The field logbook should clearly state that the samples have been composited, which samples were composited, and why the compositing was done.

Samples taken for geotechnical analysis will be undisturbed samples, collected using a thin-walled (shelby tube) sampler.

4.0 Maintenance

Not Applicable.

5.0 Precautions

a. Refer to the Health and Safety Plan.
b. Soil samples will not include vegetative matter, rocks, or pebbles, unless the latter are part of the overall soil matrix

6.0 References

ASTM Method D1586-84, Penetration Test and Split-Barrel Sampling of Soils.

ASTM Method D1587-83, Thin Walled Sampling of Soils.

SOP 2

WATER LEVEL AND WELL DEPTH MEASUREMENTS

1.0 Scope and Application

The purpose of this SOP is to delineate protocols for measuring water level and well depth. This procedure is applicable to the sampling of monitoring wells and must be performed prior to any activities that may disturb the water level, such as purging or aquifer testing.

2.0 Material

a. Electronic water level indicator (diameter) with cable measured at 0.01-foot increments. -or- Weighted Steel Tape and chalk -or- Transducer and datalogger;

b. Oil-water interface probe;

c. Plastic sheeting; and

d. Photo ionization detector (PID) or intrinsically-safe flame ionization detector (FID)

3.0 Procedure

3.1 Preliminary Steps

a. Locate the well and verify its position on the site map. Record whether positive identification was obtained, including the well number and any identifying marks or codes contained on the well casing or protective casing. Gain access to the top of the well casing.

b. Locate the permanent reference mark at the top of the casing. This reference point will be scribed, notched or otherwise noted on the top of the casing. If no such marks are present, measure to the top of the highest point of the well casing and so note this fact in field logbook. Determine from the records and record in the notebook the elevation of this point.

c. Record any observations and remarks regarding the completion characteristics and well, such as evidence of cracked casing or surface seals, security of the well (locked cap), and evidence of tampering.

d. Keep all equipment and supplies protected from gross contamination; use clean plastic sheeting. Keep the water level indicator probe in its protective case when not in use.

3.2 Operation

a. Sample the air in the well head for gross organic vapors by lifting the well cap only high enough for an organic vapor meter (PID or FID) probe to be entered into the well casing. This will indicate the presence of gross volatile contaminants as well as indicating potential sampler exposure.

b. Remove cap. Allow well to vent for 60 to 90 seconds. Resample headspace. Record both readings. If the second reading is lower than the first, use the second reading to determining whether respiratory protection will be required during subsequent water level and well depth determinations, and sampling.

Note that all headspace sampling must be performed at arm's length and from the upwind side of the well if possible.

3.2.1 If non-aqueous phase liquid (NAPL) contamination is suspected, use an interface probe to determine the existence and thickness of NAPLs.

a. Open the probe housing, turn the probe on, and test the alarm. Slowly lower the probe into the well until the alarm sounds. A continuous alarm indicates a NAPL while an intermittent alarm indicates water. If a NAPL is detected, record the initial level (first alarm). Mark the spot by grasping the cable with the thumb and forefingers at the top of the casing. If a mark is present on the casing, use the mark as the reference point. If no mark is present, use the highest point on the casing as the reference point. Withdraw the cable sufficiently to record the depth.

b. Continue to slowly lower the probe until it passes into the water phase. Slowly retract the probe until the NAPL alarm sounds and record that level in the manner as described above.

c. Record the thickness of the LNAPL.

d. Continue to slowly lower the interface probe through the water column to check for the presence of DNAPL.

e. Measure and record the thickness of the DNAPL layer (if any) as described above.

f. Slowly raise the interface probe, recording the depth to each interface as the probe is withdrawn. If there is a discrepancy in depths, clean the probe sensors and re-check the depths.

g. NOTE: Air/liquid interface depth is more reliable if probe is lowered into liquid. NAPL/water depths are more accurate if probe is moved from water.

h. Always lower and raise interface probe slowly to prevent undo mixing of media.

i. Always perform NAPL check in wells installed in areas with suspected NAPL contamination. Always perform NAPL check if headspace test reveals presence of volatiles. Always perform NAPL check the first time a well is sampled. If a well has been sampled previously and no NAPLs were present and none of the preceding conditions are met, the NAPL check may be omitted.

3.2.2 If no NAPL is present use an electronic water level detector as follows.

a. Remove the water level indicator probe from the case; turn on the sounder, and test check the battery and sensitivity scale by pushing the red button. Adjust the sensitivity scale until you can hear the buzzer.

b. Slowly lower the probe and cable into the well, allowing the cable reel to unwind. Continue lowering until the meter buzzes. Very slowly, raise and lower the probe until the point is reached where the meter just buzzes. Marking the spot by grasping the cable with the thumb and forefingers at the top of the casing. If a mark is present on the casing, use the mark as the reference point. If no mark is present, use the highest point on the casing as the reference point. Withdraw the cable and record the depth.

3.2.3 Alternatively, use a steel tape with an attached weight if aquifer gradients are lower than 0.05 ft/ft. Due to the possibility of adding unknown contaminants from chalk colorants, only white chalk is permitted.

a. Rub chalks onto the first 1-foot of the steel tape and slowly lower the chalked end into the well until the weighted end is below the water surface. (A small splash can be heard when the weighted end hits the water surface.)

b. Using the method described above, read and record the length from the steel tape.

c. Remove the steel tape. The chalk will be wet or absent where the tape was below the water surface. Locate, read, and record this length. Subtract wetted length from total length and record the difference. This is the depth to water table.

4.0 References

McAlary, T. A., and Barker, J. F., 1987. "Volatilization Losses of Organics During Ground Water Sampling from Low Permeability Materials" in Ground Water Monitoring Review, Fall, 1987.

Thornhill, Jerry T., 1989. Accuracy of Depth to Groundwater Measurements; In EPA Superfund Ground Water Issue, EPA/540/4-89/002.

SOP 3

GROUNDWATER SAMPLING

All monitoring wells will be sampled using the low-flow sampling method. Wells will be sampled in order of most distant from suspected sources to closer to suspected sources. Thus, the upgradient well (MW-1) will be sampled first. Presample purging will be accomplished using USEPA low-flow sampling guidance. This purging will be accomplished using a variable speed submersible pump, provided each well is capable of producing a recharge greater than 0.1 liter per minute (L/min), which is the practical lower limit of pump performance. It is anticipated that the typical flow rates will range from 0.1 L/min to 1 L/min while attempting to maintain minimal drawdown. The groundwater samples will be collected once the water quality parameters stabilize. The following groundwater sampling procedures for the low-flow sampling method will be used:

1. A clean piece of plastic sheeting will be spread on the ground around the well to protect the sampling equipment from possibly becoming contaminated.
2. After opening the well, headspace readings in the well and in the breathing zone immediately above the well will be taken with a PID.
3. If VOCs are measured in the well with the PID, then the need for donning personal protective equipment (PPE) will be evaluated. If the readings are continuous (exceeding 1 parts per million [ppm] but not greater than 5 ppm), then Level C PPE will be worn while purging and sampling the well. If the readings are continuous above 5 ppm, the site will be evacuated. Based on previous data from wells, these conditions are very unlikely.
4. Prior to purging any of the wells, the depths to the top of the water and bottom of the well will be measured for each well with an electric water level indicator with an accuracy of 0.01 foot, from a permanently marked reference point located on top of the polyvinyl chloride (PVC) riser pipe. Measurements will be taken three times to ensure accuracy and recorded in the field logbook. The tape and probe will be decontaminated between measurements at different wells.
5. One equivalent well volume (the volume of water standing within the well casing and well screen, plus the volume of water within the saturated portion of the sand pack [assuming 30 percent porosity]) will be calculated.
6. The submersible pump will be slowly lowered into the well until it is at the mid-point of the screened interval or at the mid-point of the water column if the static water level is below the top of the screen. The water level indicator will be lowered to the top of the water column so that the water level can be monitored while purging the well.
7. Purging will begin at the lowest pump rate necessary to pump water out of the well and eliminate air bubbles from the tubing. As soon as the air bubbles are eliminated, the pumping rate will be adjusted to the lowest setting and then gradually increased until it matches the recharge rate, which could exceed 1 L/min as long as minimal drawdown (<0.1 m) is maintained. Water quality

parameters including turbidity, pH, temperature, conductivity, redox potential, and dissolved oxygen (DO) will be measured at the beginning of purging using an in-line monitoring system. Parameters will be measured and recorded approximately every 10 minutes while purging. The readings will be recorded on a Groundwater Low-Flow Sampling Form (provided in Appendix C) along with the time of the reading, the water level reading, the flow rate, a description of the water, and the cumulative volume extracted. All purge water will be containerized for off site disposal.

8. To prevent aeration of the sample, the water level will not be lowered below the top of the well screen during purging wherever possible. Every effort will be made to minimize drawdown and, consequently, minimize aeration.
9. A sample will be collected when drawdown has reached equilibrium, the water quality parameters have stabilized, and at least one equivalent well volume of water has been evacuated from the well (if practicable). Stabilization is defined as three successive readings in which the pH changes by less than 0.1 pH unit; temperature changes 1°F or less; and conductivity and turbidity change by less than 10 percent. At this time, the pumping rate will be reduced to approximately 0.1 L/min.
10. If the recharge rate of the well is very low and a steady pumping rate cannot be maintained without drawing down the water level, the well will be purged to the top of the screened interval at a flow rate less than or equal to 1 L/min. Sampling will commence as soon as the volume in the well recovers sufficiently to permit collection of samples.
11. Samples will be collected using polyethylene tubing attached to the discharge point of the pump with stainless steel clamps.
12. Sample bottles that are not pre-preserved will be triple-rinsed using sample water.
13. All monitoring wells will be sampled for the required parameters. The sample bottles will be filled in the order of decreasing volatility.
14. The number of sample bottles, sample container types, and sample preservation methods with respect to specific analytes will be recorded on the COC form.
15. Sample bottles will be labeled, enclosed in a plastic bag, and placed in a cooler maintained at 4±2°C immediately after sample collection and preservation.
16. A final measurement for turbidity, pH, temperature, conductivity, redox potential, and DO will be obtained for each sample.
17. Stabilization parameter readings, PID readings, purge volume, flow rate, and sample information will be entered onto a Groundwater Low-Flow Sampling Form.
18. The sample fraction for metals analysis will be filtered using a 0.45-micron in-line filter prior to filling the appropriate pre-preserved bottle. Disposable sampling equipment will be discarded. The pump and tubing will be decontaminated.

SOP 4

FIELD EQUIPMENT DECONTAMINATION

1. Scope and Application

The objective of this SOP is to describe the proper procedures for decontaminating downhole and sampling equipment used to perform field investigations. Decontamination of field equipment is necessary to ensure chemical analyses reflect actual concentrations at sampling locations by maintaining the quality of samples and preventing cross-contamination. Furthermore, decontamination reduces the health hazards to field personnel and prevents the spread of contaminants off-site.

2.0 Materials

Sampling equipment includes split spoons, liners, hand augers, bailers, bowls, knives, scoops, water samplers, non-disposable filtration equipment, or any equipment that directly contacts samples. Equipment necessary to complete decontamination procedures includes:

a. 5-gallon or larger plastic buckets and/or troughs;

b. Laboratory-grade detergent (phosphate free);

c. Stiff-bristle brushes capable of cleaning the inside and outside of equipment;

d. Teflon sprayers or wash bottles, or 2- to 5-gal manual pump sprayer (pump sprayer material must be compatible with the solution used);

e. Plastic sheeting;

f. Disposable wipes;

g. Aluminum foil;

h. Potable water;

i. Deionized, organic-free water [American Society for Testing and Materials (ASTM) Type II or equivalent] [high-pressure liquid chromatography (HPLC)-produced water is not acceptable];

j. (Note: For large projects, the equivalent of ASTM Type II water can be obtained on-site by processing tap water with a deionization/organic filtration system);

k. Pesticide-grade or better methanol or, where required by state or Environmental Protection Agency (EPA) region, isopropanol (Note: the use of methanol is preferred to isopropanol because of the potential for generation of acetone as a photodegradation product of isopropanol);

l. Gloves, goggles, and other protective clothing as specified in the Site Health and Safety Plan; and

m. Steam cleaner.

3.0 Procedure

3.1 Before samples are collected, the equipment used to collect water, soil, sediment, and other samples will be decontaminated by the following method.

a. Set up a decontamination line on plastic sheeting covering the ground or on a table covered by plastic sheeting or aluminum foil (shinny side away from equipment). At a minimum, clean plastic sheeting must be used to cover the ground beneath decontamination equipment and plastic sheeting or aluminum foil must cover tables or other surfaces where decontaminated equipment is to be placed. The decontamination area should be located away from potential contaminant sources (e.g., construction areas, waste piles, etc.) to reduce or eliminate potential cross- contamination during decontamination. The decontamination area should progress from "dirty" to "clean" and end with an area for drying equipment.

b. Dislodge as much loose dirt as possible from equipment before beginning the decontamination process. Wash the item thoroughly in a bucket or trough of soapy water. Use a stiff-bristle brush to dislodge any clinging dirt. Before washing, disassemble any items that might trap contaminants internally.

c. Rinse in second bucket or trough containing tap water or use a hand sprayer. Rinse water should be replaced as necessary (generally when water is cloudy) when not using a hand sprayer.

d. Repeat step c in a separate bucket or trough for a more thorough rinse (optional).

e. Using a hand sprayer, rinse the item with ASTM Type II or equivalent water over a separate bucket.

f. Using a hand sprayer, rinse the item with methanol or isopropanol; whichever is appropriate, over a separate bucket.

g. If the equipment will have time to fully air dry before its next use, allow to air dry. If the equipment will not be allowed to fully air dry, repeat step f before reassembling or using any equipment.

h. If equipment will not be used immediately after drying wrap in aluminum foil (dull side in) for storage and transport.

i. Record decontamination protocol, equipment types, and date in the appropriate field logbook at each occurrence.

j. After decontamination activities are complete, collect all contaminated waters, solvents, plastic sheeting, aluminum foil, disposable gloves, boots, and clothing. Place contaminated items in properly labeled containers for disposal. Liquids and solids must be drummed separately.

3.2 Downhole equipment consists of nonsampling tools such as hollow-stem augers, drill pipe, bits, casing, and screen. Drill rigs, backhoes, and other heavy machinery are also included. Equipment necessary to complete decontamination procedures includes:

a. Plastic sheeting or steel, prefabricated decontamination pad;

b. Metal, wooden, or plastic sawhorses or other stands;

c. Laboratory-grade detergent (phosphate free);

d. Steam cleaner;

e. Stiff-bristle brushes;

f. 2- to 5-gallon manual pump sprayer (pump sprayer must be compatible with the solution used);

g. De-ionized, organic-free water (ASTM Type II or equivalent); and

h. Gloves, goggles, boots, and other protective clothing as specified in the site-specific Work Plan.

3.3 Before drilling, sampling, excavating, leaving the site, and in between each location, all drilling equipment used in field sampling activities must be decontaminated. All downhole augering, drilling, and sampling equipment shall be sandblasted (off-site) if it is new, painted equipment (such as split spoons or auger flights) or exhibits build-up of rust or caked material. Heavy equipment not directly used for sampling will be decontaminated at a designated area designed to contain decontamination wastes and waters. The following steps must be taken when decontaminating this equipment.

a. Set up a decontamination pad that is large enough to fully contain the equipment to be cleaned. If practical, a centralized decontamination area should be established. This area should be set up to contain contaminated rinse waters and may be constructed using one or more layers of heavy plastic sheeting with berried sides, a lined excavated pit, or a bermed concrete or asphalt pad. If possible, the area should be constructed to eliminate or minimize any overspray or wind-blown spray from decontamination activities (e.g., plastic sheeting secured to a wood frame surrounding the area). The decontamination area must be constructed so that fluids can be easily pumped from the area to holding containers.

b. Set up a "clean" area upwind of the decontamination area to receive cleaned equipment for air-drying. At a minimum, clean plastic sheeting must be used to cover surfaces on which decontaminated equipment is to be placed.

c. Don personal protective equipment as specified in the site-specific Health and Safety Plan before beginning cleaning activities.

d. For heavy equipment, areas exposed to contaminated soil should be sprayed using a steam-spray unit.

e. For smaller equipment such as augers, place the objects to be cleaned on metal or plastic-covered wooden sawhorses, supports, or decontamination trays. Using the steam-spray unit, spray the contaminated equipment. Be sure to spray inside corners and gaps especially well; use a brush, if necessary, to dislodge dirt.

f. For steps d and e, aim the sprayer downward as much as possible to avoid spraying outside the decontamination area.

g. If the condition of downhole or heavy equipment warrants using hot soapy water in the steam-spray unit, rinse the equipment with clean, clear tap water following the steam spray. If using steam spray without a detergent the tap water rinse is not necessary.

h. Remove the equipment from the decontamination area to the "clean" area to dry.

i. Record decontamination protocol, equipment types, and date in the appropriate field logbook.

j. After decontamination procedures are complete, or any time the decontamination fluids fill the bermed or contained area,

decontamination fluids will be collected and transfer to appropriate containers. Place all plastic and personal protective equipment into appropriate containers. All containers must be labeled properly for disposal. Liquids and solids must be drummed separately.

3.4 Any pump in which potentially contaminated fluids come into contact with any part of the pump equipment requires decontamination. This requirement does not include peristaltic pumps. Dedicated tubing should be used for peristaltic pumps so decontamination will not be needed. If the tubing is to be reused, it must be properly decontaminated. Equipment necessary to complete decontamination procedures includes:

a. ASTM Type II water;

b. Plastic sheeting;

c. Sufficient containers, two for decontamination procedures and one for waste water;

d. Laboratory-grade detergent (phosphate free); and

e. Gloves, goggles, boots, and other protective clothing as specified in the site-specific Work Plan.

3.5 Following the use of a pump for development, purging, and/or sampling, the pump should be decontaminated by the following method.

a. Set up containers in a line on the plastic.

b. Add potable water with a small amount of detergent to the first container; add potable water alone to the second container. There should be sufficient water to accomplish the decontamination procedure in each container.

c. Place one container near enough to the decontamination area to collect the spent decontamination fluids.

d. Place the pump in the first container and pump enough water through it to equal at least three pump-and-pump-hose volumes. Pump the water into the waste drum. Move the pump to the second container and repeat. Rinse and fill an additional container with ASTM Type II water and repeat again. However, one volume of ASTM Type II water is the minimum amount required for the final rinse.

e. Record decontamination protocol, equipment types, and date in the appropriate field logbook. After decontamination activities are complete, collect all contaminated water; solvents; plastic sheeting; aluminum foil; and disposable gloves, boots, and clothing. Place contaminated items in properly labeled drums for disposal. Liquids and solids must be drummed separately.

4.0 Restrictions/Limitations

Filtering of samples, when required, should be done in the field as quickly as possible. The sample shall be preserved immediately after filtration. Three basic filter systems are typically used: an in- line disposable filter, an inert gas over-pressure filtration system, and the vacuum filtration system. For systems where disposable filters are used, decontamination is not required. The filters should be discarded after the desired sample is collected. Purchased ASTM Type II water can be expensive. ASTM Type II water can be produced on-site with a mobile filtration system. All ASTM Type II water must have field-blank samples collected and analyzed at the proper frequency to ensure the purity of the water.

5.0 References

None.

SOP 5

FIELD LOGBOOK

1.0 Scope and Application

The purpose of this SOP is to delineate protocols for recording daily field activities and sampling information in the field logbook.

2.0 Material

a. Field logbook (a)
b. Indelible ink pen.

3.0 Procedure

1. Use prenumbered, bound, and dedicated logbooks for each project.

2. Enter the project name, project number, and name of field personnel on the inside front cover of the logbook.

3. Record the date and time of each entry on each page.

4. At the end of each day's activities or at the end of a particular task, draw a diagonal line at the conclusion of the entry and initial.

5. Record all pertinent information regarding excavation, sample collection, and sample handling – as well as visual observations and the names of site visitors.

6. Include sufficient detail in the field logbook such that decision logic can be traced upon review:

   a. Project name.
   b. Sampling locations.
   c. Date and times.
   d. Sampling personnel present (identify responsibilities, if applicable).
   e. Level of PPE worn.
   f. Weather or any environmental condition that may affect the samples.
   g. Equipment used.
   h. Calibration data for field screening instruments.

(a) Preprinted, bound forms are approved as well.

i. Field measurements (e.g., pH, conductivity, explosivity, water depth, photoionization detector (PID) readings).
j. Deviations from methods in the approved work plans.
k. A sketch of the sampled area and landmarks (denoting sample numbers and locations).
l. Type of sample (e.g., groundwater or surface water).
m. Sampling methodology, including distinction between grab and composite samples.
n. Field observations (e.g. oily sheen on groundwater sample, incidental odors, soil).
o. Description of the system for identifying and tracking samples collected and their associated QC samples.
p. Sample shipment (e.g., name of laboratory and shipping agent – Federal Express, United Parcel Service, etc.), color, grain size, plasticity, moisture content, layering, Unified Soil Classification System (USCS).
q. Decontamination procedures.
r. Names and affiliations of site visitors.
s. Initials and date on each page.
t. Lining out of any remaining blank portion of pages with a signature and date.

Sampling situations vary widely. However, the field logbook should contain sufficient information so that the sampling activity can be reconstructed based on the documentation.

4.0 Maintenance

Not applicable.

5.0 Precautions

None.

6.0 References

USACE, 1994. *Requirements for the Preparation of Sampling and Analysis Plans*, EM 200-1-3, September 1994.

USEPA, 1991. *User's Guide to the Contract Laboratory Program*, EPA/540/O91/002, Directive 9240.0-01D, Office of Emergency and Remedial Response, January 1991.

USEPA, 1990. *Sampler's Guide to the Contract Laboratory Program*, EPA/540/P-90/006, Directive 9240.0-06, Office of Emergency and Remedial Response, Washington, D.C., December 1990.

USEPA, 1980. *Interim Guide and Specifications for Preparing Quality Assurance Project Plans*, QAMS-005/80.

SOP 6

SAMPLE LABELS

1.0 Scope and Application

The purpose of this standard operating procedure is to delineate protocols for the use of sample labels. Every sample will have a sample label uniquely identifying the sampling point. An example label is included as Figure 1. Other formats with similar levels of detail are acceptable.

2.0 Material

a. Sample Label
b. Indelible lab marker

3.0 Procedure

The following steps describe how to use the sample labeling system:

3.1 As each sample is collected/selected, fill out a sample label. Enter the following information on each label:

a. Project Name
b. Project Number
c. Location/Site I.D. - enter the well # or surface water sampling #, and other pertinent information concerning where the sample was taken.
d. Date of Sample Collection
e. Time of Sample Collection
f. Analyses to be Performed (Note: due to number of analytes, details of analysis should be arranged with lab.)
g. Whether Filtered or Unfiltered (water samples only)
h. Preservatives (water samples only)
i. The Number of Containers for the Sample (1 of 2, 2 of 2)

3.2 Double-check the label information to make sure it is correct. Detach the label, remove the backing and apply the label to the sample container. Cover the label with clear tape, ensuring that the tape completely encircles the container.

3.3 Record the Sample Number and designated sampling point in the field logbook, along with the following sample information:

a. Time of sample collection (each logbook page should be dated)
b. The location of the sample

c. Organic vapor meter or photoionization meter readings for the sample (when appropriate)
d. Any unusual or pertinent observations (oily sheen on groundwater sample, incidental odors, soil color, grain size, plasticity, etc.)
e. Number of containers required for each sample
f. Whether the sample is a QA sample (split, duplicate or blank)

A typical logbook entry might look like this:

7:35 AM Sample No. MW-3. PID = 35 PPM
Petroleum odor present. Sample designated MW-3-001.

3.4 Place the sample upright in the designated sample cooler. Make sure there is plenty of ice in the cooler at all times.

4.0 Maintenance

Not Applicable.

5.0 Precautions

Note that although incidental odors should be noted in the logbook, it is unwise from a health and safety standpoint to routinely "sniff test" samples for contaminants.

6.0 References

U.S. EPA. 1980, Interim Guidelines and Specifications for Preparing Quality Assurance Project Plans, QAMS-005/80

FIGURE 1
EXAMPLE SAMPLE LABEL

PROJECT NAME _____ PROJECT NUM. _____

SAMPLE LOCATION/SITE ID _____

DATE: ____/____/____ TIME: _____:_____

ANALYTES: METALS VOC EXPLOSIVES ORGANICS OTHER

FILTERED: [NO] [YES]

PRESERVATIVE: [NONE] [HNO_3] [OTHER _____]

SAMPLER: _____

SOP 7

SAMPLE PACKING AND SHIPPING

1.0 Scope and Application

The purpose of this Standard Operating Procedure (SOP) is to delineate protocols for the packing and shipping of samples to the laboratory for analysis.

2.0 Material

a. Waterproof coolers (hard plastic or metal)
b. Metal cans with friction-seal lids (paint cans)
c. Custody seals
d. Packing material [a]
e. Sample Documentation
f. Ice
g. Plastic Garbage Bags
h. Clear Tape
i. Zip seal plastic bags

3.0 Procedure

a. Check cap tightness and verify that clear tape covers label and encircles container.
b. Wrap sample container in bubble wrap or closed cell foam sheets.
c. Enclose each sample in a clear zip-seal plastic bag.
d. Place several layers of bubble wrap, or at least 1" of vermiculite on the bottom of the cooler. Line cooler with open garbage bag, place all the samples upright inside a garbage bag and tie the bag.
e. Double bag and seal loose ice to prevent melting ice from soaking the packing material. Place the ice outside the garbage bags containing the samples.
f. Pack shipping containers with packing material (closed cell foam, vermiculite, or bubble wrap). Place this packing material around the sample bottles or metal cans to avoid breakage during shipment.
g. Enclose all sample documentation (i.e., Field Parameter Forms, COCs) in a waterproof plastic bag and tape the bag to the underside of the cooler lid. If more than one cooler is being used, each cooler will have its own documentation.

---

[a] Permissible packing materials are: a) (non-absorbent) bubble wrap or closed cell foam packing sheets; b) (absorbent) vermiculite. Organic materials such as paper, wood shavings (excelsior), and cornstarch packing "peanuts" will not be used.

h. Seal the coolers with signed and dated custody seals so that if the cooler were opened, the custody seal would be broken. Place clear tape over the custody seal to prevent damage to the seal.

i. Tape the cooler shut with packing tape over the hinges and place tape over the cooler drain.

j. Ship all samples via overnight delivery on the same day they are collected if possible.

4.0 Maintenance

Not Applicable.

5.0 Precautions

Any samples suspected to be of medium/high contaminant concentration or containing dioxin must be enclosed in a metal can with a clipped or sealable lid (e.g., paint cans). Label the outer metal container with the sample number of the sample inside.

6.0 References

U.S. EPA. 1990. Sampler's Guide to the Contract Laboratory Program. EPA/540/P-90/006, Directive 9240.0-06, Office of Emergency and Remedial Response, Washington, D.C., December 1990.

U.S. EPA. 1991. User's Guide to the Contract Laboratory Program. EPA/540/O-91/002, Directive 9240.0-01D, Office of Emergency and Remedial Response, January 1991.

U.S. EPA. 1980, Interim Guidelines and Specifications for Preparing Quality Assurance Project Plans, QAMS-005/80

Appendix C:

Site Specific Health and Safety Plan

FINAL SITE SPECIFIC HEALTH & SAFETY PLAN

REMEDIAL INVESTIGATION OF THE FORMER BUILDING 6621 PESTICIDES SHOP AT FORT GEORGE G. MEADE, MARYLAND

Prepared for
Fort George G. Meade
ANME-PWE
Environmental Management Office
Fort Meade, Maryland 20755-5115

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Attachment A Site Material Safety Data Sheets (MSDS)

Attachment B Site Forms:
URS SMS Form 29-1 Hazard Assessment Certification Form
URS SMS Form 24-9 Field First Aid Kit Supply List
URS SMS Form 49-1 Incident Report Form
USACE Eng Form 3394

Attachment C Chemical Information Table

Attachment D URS Safety Management Standards

ACGIH	American Conference of Governmental Industrial Hygienists
AL	Action Level
CFR	Code of Federal Regulations
CHSO	Collateral Health and Safety Officer
CIH	Certified Industrial Hygienist
CPR	Cardiopulmonary resuscitation
DEET	Diethyl-m-toluamide
EMO	Environmental Management Office
eV	electron volt
GFCI	Ground fault circuit interrupter
HSER	Health, Safety, and Environment Representative
HSMS	Health and Safety Program and Management System
JHA	Job Hazard Analyses
LEL	Lower explosive limit
mg/m^3	milligrams per cubic meter
mg/kg	milligrams per kilogram
OHS	Occupational Health Specialist
OSHA	Occupational Safety and Health Administration
MC	Medical Consultant
MSDS	Material Safety Data Sheet
NIOSH	National Institute for Occupational Safety and Health
PEL	Permissible Exposure Limit
PID	Photo ionization detector
PM	Project Manager
ppm	Parts per million
PPE	Personal protective equipment
PCBs	Polychlorinated biphenyls
RI	Remedial Investigation
RHSEM	Regional Health, Safety, and Environment Manager
SM	Site Manager
SMS	Safety Management Standards
SSHP	Site Safety and Health Plan

TLV	Threshold Limit Value
USACE	U.S. Army Corps of Engineers
VOC	Volatile organic compounds

1.1 GENERAL

URS Group, Inc. (URS) has been contracted by Fort George G. Meade (Fort Meade) and the Baltimore District of the U.S. Army Corps of Engineers (USACE) to conduct a Remedial Investigation (RI) for surface and subsurface contamination at the Former Building 6621 Pesticides Shop located at Fort Meade, Maryland. This Site Safety and Health Plan (SSHP) establishes procedures to protect site personnel from potential health and safety hazards that may occur during the site investigation.

This SSHP, and each of its provisions, is applicable only to, and for use only by, URS, its affiliates, and its subcontractors. Any use of this Plan by other parties, including, without limitation, third party contractors on projects where URS is providing engineering, construction management or similar services, without the express written permission of URS, will be at that party's sole risk, and URS shall have no responsibility. The existence and use of this Plan by URS shall not be deemed an admission or evidence of any acceptance of any safety responsibility by URS for other parties unless such responsibility is expressly assumed in writing by URS in a specific project contract.

1.2 SITE BACKGROUND

Building 6621 was located at the southwest corner of York Avenue and Gordon Street, approximately 700 feet east of Mapes Road on Fort Meade. The building was demolished and the site regraded in 1996. The building was labeled "Mess Hall" in the Real Property records, but had housed a Pesticide Shop for some time prior to being torn down.

Previous environmental investigations have occurred at the site and prior sampling has been conducted. All investigations have been conducted since the building was torn down in 1996 and the site had been regraded. Some of the chemicals kept at Building 6621 in the past include DDD, DDT, malathion, diazinon, chlordane, baygon, and several brands of rodenticides. Several of these pesticides, along with arsenic and chromium, have been detected in site soils.

1.3 SCOPE OF WORK

The scope of this project is to review historical documentation to identify locations to collect environmental samples and then assess potential surface and subsurface contamination at the probable environmentally impacted sites on Former Building 6621 area. The objectives will be accomplished through a review of background information, direct-push soil and groundwater sampling, and submitting samples for laboratory chemical analysis.

2.1 GENERAL

All URS and subcontractor on-site personnel will be responsible for complying with the requirements of this SSHP. The Project Manager (PM) and the Site Manager (SM) will be responsible for implementing the SSHP and ensuring that its requirements are enforced. Managers will be assisted in this effort by URS health and safety staff.

2.2 PROJECT MANAGER

The PM will be responsible for the overall direction, implementation, and enforcement of health and safety requirements. Other responsibilities will include:

- Verify the project is performed in a manner consistent with the URS Corporate Health and Safety Program and Safety Management Standards (SMS).
- Ensure that an SSHP is prepared and approved.
- Provide project information for the development of an SSHP.
- Monitor compliance with the SSHP by URS and subcontractor personnel.
- Ensure adequate resources are provided to the health and safety staff so that they may carry out their duties.
- Maintain communication with the Environmental Management Office (EMO) representative.

The PM has the authority to take the following actions:

- Determine personnel assignments on this project.
- Stop field activities if an imminently dangerous situation exists. The Health, Safety, and Environmental Representative (HSER) and/or the Regional Health, Safety, and Environment Manager (RHSEM) will immediately review the emergency situation.

2.3 SITE MANAGER

The SM will be responsible for the daily implementation and enforcement of the SSHP, including the following responsibilities:

- Ensure site activities are performed in a manner consistent with the URS Health and Safety Program and Management System (HSMS) and SMS, and this SSHP.
- Report health and safety deficiencies to the PM, and include a corrective action implementation schedule and/or notice of completion of corrective actions.
- Ensure site activities are scheduled with adequate personnel and equipment resources to perform scheduled activities safely.
- Ensure adequate communication between field personnel and emergency response personnel is available.
- Maintain communication with subcontractors.

- Stop site activities if an imminently dangerous situation exists. The emergency situation will be reviewed immediately with the PM and RHSEM.

2.4 REGIONAL HEALTH, SAFETY, AND ENVIRONMENT MANAGER

The RHSEM is a Certified Industrial Hygienist (CIH) with experience in field investigations. The RHSEM has the following responsibilities:

- Interface with the PM and the Collateral Health and Safety Officer (CHSO) about project health and safety-related issues.
- Approve the SSHP, including amendments, if any.
- Approve revised or new health and safety protocols for site activities.
- Monitor compliance with the SSHP; may conduct a health and safety audit during ongoing site activities.
- Determine and implement personnel disciplinary actions for safety violations.
- Approve the appointment of the CHSO and any replacement CHSOs.
- Stop site activities if an imminently dangerous situation exists.
- Remove personnel from the project if their actions endanger their health and safety, or the health and safety of their co-workers.

2.5 COLLATERAL HEALTH AND SAFETY OFFICER

The SM will also act as a CHSO. A “collateral duty Health and Safety Officer (CHSO)” is a URS employee assigned the duty and/or responsibility of an HSO who is not primarily employed by URS as a health and safety professional. The CHSO will have the following responsibilities:

- Maintain health and safety equipment on site.
- Inspect ongoing site activities, and report any health and safety deficiencies to the PM and HSER or RHSEM.
- Interface with the HSER/RHSEM about on-site implementation of the SSHP.
- Report all incidents, accidents, and near misses to the PM and HSER/RHSEM.
- Accompany the subcontractor work crew when working on site.
- Stop site activities if an imminently dangerous situation exists. The emergency situation will be reviewed immediately with the PM and HSER/RHSEM.

2.6 SUBCONTRACTOR WORK CREW

The subcontractor work crew team members will have the following responsibilities:

- Immediately report any unsafe or potentially hazardous conditions to the CHSO.
- Report all incidents, accidents, and near misses, no matter how minor they may seem, immediately to the CHSO.

- Maintain knowledge of the information, instructions, and emergency response procedures contained in this SSHP.
- Comply with the requirements and procedures set forth in this SSHP, and with any amendments.

3.1 INITIAL SITE-SPECIFIC SAFETY TRAINING

All on-site personnel assigned to the project will have the initial 40-hour Hazardous Waste Operations (HAZWOPER) training as required by 29 Code of Federal Regulations (CFR) 1910.120, as well as current 8-hour refresher training. In addition, the SM will have completed an 8-hour supervisor training course.

Prior to the start of site work, all personnel assigned to the project will attend initial site-specific safety training. The SM and/or the CHSO will conduct the training, which will specifically address the activities, procedures, and equipment applicable to the site operation. The training will include the site layout, potential hazards, monitoring protocols, safety procedures, and emergency response services, as outlined in this SSHP. The training session will allow site personnel to clarify any issues they do not understand, and will reinforce individual responsibilities regarding health and safety during site work. Workers will fill out an SSHP Compliance Agreement (Section 12.0) during this training session.

3.2 SITE SAFETY BRIEFINGS

The SM or CHSO will present daily site safety briefings (i.e., tailgate meetings) to all personnel on site prior to the start of the work shift. The purpose of the briefings is to assist personnel in safely conducting the scheduled work activities. The briefings will include weather-related information, instructions for new operations to be conducted, and/or safe work practices. The briefings will also provide an opportunity to identify safety-related performance deficiencies noted during daily activities or during a safety audit.

3.3 FIRST AID/CPR TRAINING

At least two members of the URS staff assigned to the project will have American Red Cross (or equivalent) first aid and cardiopulmonary resuscitation (CPR) training. At least one of these persons will be present on site at all times. The CHSO will maintain all training documentation.

3.4 TASK-SPECIFIC TRAINING—HAZARD COMMUNICATION

In accordance with Occupational Safety and Health Administration (OSHA) Standard 1910.1200, Section 01.B.04 of USACE EM 385-1-1, and URS SMS 2, Worker Right-to-Know (Hazard Communication), Material Safety Data Sheets (MSDSs) for each hazardous chemical that will be used on site are located in Attachment A. Prior to the start of the project, task-specific training will be held that will cover the following elements of the Hazard Communication Standard:

- Regulatory requirements of OSHA 29 CFR 1910.1200 and USACE EM 385-1-1
- Location of the program and MSDSs
- A review of each MSDS—i.e., hazards, personal protective equipment (PPE) requirements, safe handling procedures, spill control measures, etc.
- How to detect the presence or release of chemicals used on site

- How to read an MSDS

All site personnel who will be working with hazardous chemicals must attend this task-specific training.

3.5 MEDICAL SURVEILLANCE REQUIREMENTS

All personnel must comply with medical surveillance requirements outlined in URS SMS 24, Medical Screening and Surveillance. URS requirements meet all OSHA and USACE criteria. Personnel required to comply with SMS 24 must have passed the URS medical surveillance examination (or equivalent) within 1 year prior to reporting to the project. The PM will verify that all URS and subcontractor personnel meet applicable OSHA medical surveillance requirements prior to the start of site work. Documentation regarding medical surveillance clearance will be maintained by the CHSO. Documentation will include a signed statement that each employee is certified by an occupational physician as capable of wearing respiratory protection.

3.6 ACCIDENT/INCIDENT MEDICAL SURVEILLANCE

All accidents and potential exposures must be reported **immediately** to the CHSO, who will coordinate with the HSER/RHSEM and/or Occupational Health Specialist (OHS) to arrange for medical exams or tests that may be indicated as part of the URS medical surveillance program. Depending on the type of incident, it may be critical to perform tests within 24 to 48 hours. The URS Medical Consultant (MC), Dr. Peter Greaney of WorkCare, will advise the RHSEM/OHS on the type(s) of test(s) required to accurately assess the injury. Refer to Section 11.4 for incident reporting guidelines. *Failure to report an injury or incident immediately will result in disciplinary action.*

4.1 INTRODUCTION

The potential hazards associated with the Former Building 6621 Pesticides Shop include chemical, physical, and biological hazards. The hazards at the site have been evaluated using the URS HSMS SMS Checklist (Attachment B). This form has been used as a tool to conduct and document the hazard analysis process and to identify the URS SMSs specific to the tasks at the site. The hazard assessment in this section is intended to communicate to personnel the hazard and risk associated with the work.

4.2 CHEMICAL HAZARDS

Previous environmental investigations have occurred at the site and prior sampling has been conducted. All investigations have been conducted since the building was torn down in 1996 and the site had been regraded. Some of the chemicals kept at Building 6621 in the past include DDD, DDT, malathion, diazinon, chlordane, baygon, and several brands of rodenticides. Several of these pesticides, along with arsenic and chromium, have been detected in site soils. During the last sampling event, chlordane (up to 482 milligrams per kilogram (mg/kg)), 4,4-DDT (up to 103 mg/kg), and arsenic (up to 56 mg/kg) were reported as the compounds detected at the highest concentrations.

These chemicals present inhalation, contact, absorption, and ingestion hazards. Inhalation, absorption, and contact (skin and eye) are the exposure routes of concern; ingestion may occur if good personal hygiene practices are not followed. To control potential exposures, PPE will be utilized and an air-monitoring program will be implemented as described in Sections 7.0 and 8.0. The table in Attachment C provides a listing of chemicals as examples of suspect contaminants, based on information gained from site history and prior investigations of building 6621.

The information derived from this investigation will be used to evaluate the need for any controls to limit the use of the area as well as to obtain data that can be used in subsequent studies regarding potential remedial actions. Given the site history, samples will be analyzed for arsenic, chromium, organochlorine pesticides, and organophosphorus pesticides in an effort to characterize the potential contaminants.

All hazardous chemicals brought on site by URS personnel or its subcontractors will be managed in accordance with 29 CFR 1910.1200, Section 01.B.04 of USACE EM 385-1-1, and URS SMS 2, Worker Right-to-Know. A chemical inventory will be developed (including information on the approximate quantities and storage locations) for emergency response purposes. All chemicals brought on site will be properly labeled, and a copy of each chemical's MSDS will be maintained on site.

4.3 PHYSICAL HAZARDS

A variety of physical hazards may be present, but these hazards are similar to those associated with any field project. They are generally familiar to most field personnel.

4.3.1 Slip/Trip/Fall Hazards

As with any field project, uneven work surfaces and other slipping or tripping hazards may be present. Personnel must use caution when walking on unstable or uneven terrain. Proper site housekeeping, removal of trash, and orderly stacking and removal of materials will reduce slipping and tripping hazards. Proper site housekeeping will be the responsibility of all site personnel. The CHSO will make regular entries into a logbook at the end of each shift, indicating the work area is adequately clean. URS SMS 21 addresses Housekeeping.

4.3.2 Heavy Equipment Operations

Heavy equipment must be operated in a safe manner and be properly maintained such that operators and ground personnel are protected. All operations must comply with OSHA regulations, Section 16 of USACE EM 385-1-1, and URS SMS 19, Heavy Equipment.

Requirements for Operators

- Only qualified and authorized operators are allowed to operate equipment.
- Seat belts will be used at all times in all equipment and trucks.
- Operators will stop work whenever unauthorized ground personnel or equipment enter their work area and only resume work only when the area has been cleared.
- No personnel other than the authorized operator may ride on equipment.
- No personnel may be carried or lifted in the buckets or working “arms” of the equipment.

Requirements for Ground Personnel

- All ground personnel must wear orange protective vests when in work areas with any operating equipment.
- Ground personnel will stay outside of the swing zone or work area of any operating equipment.
- Ground personnel may enter the swing or work area of any operating equipment only when:
  - They have attracted the operators attention and made eye contact;
  - The operator has idled the equipment down and grounded all extensions; and
  - The operator gives the ground personnel permission to approach.
- Ground personnel shall never walk or position themselves between any fixed object and running equipment, or between two running pieces of equipment.

Equipment

- Maintain operations manuals at the site for each piece of equipment that is present on site and in use.
- Ensure that operators are familiar with the manual for the equipment and operate the equipment within the parameters of the manual.
- Ensure that all equipment is provided with roll-over protection systems.

- Verify that seatbelts are present and functional in all equipment.
- Prohibit the use of equipment that has cab glass that is cracked, broken, or missing.
- Ensure that backup alarms are functional on all trucks and equipment.
- Require all extensions, such as buckets, blades, and forks, to be grounded when not in use.
- Require brakes to be set and wheels chocked (when applicable) when not in use.

Daily inspection of equipment by the operator is required. A Daily Heavy Equipment Safety Inspection Checklist is included in URS SMS 19. Equipment deemed to be unsafe as a result of daily inspection will not be used until required repairs or maintenance occurs. During maintenance/repair, ensure that motors are turned off, all extensions are grounded or securely blocked, controls are in a neutral position, and brakes are set.

4.3.3 Underground and Overhead Utilities

Prior to initiating any drilling or excavation, utility clearances must be obtained in accordance with Section 11, USACE EM 385-1-1 and URS SMS 34. The CHSO is responsible for ensuring a safe work environment when working around electrical devices, pressurized utilities, gas, steam, water, sewage, and pipeline utilities. Pre-work walk downs should be performed with personnel familiar with the facility to identify any overhead, underground, and in-work area utilities such as electrical lines, gas lines, pipelines, and discharge of steam or hot liquids. These walk downs will minimize the chance for accidental contact with or damage to these utilities. Areas designated for intrusive investigation will be cleared of underground power cables (and other utilities) prior to the onset of work.

Subsurface work (e.g., trenching, excavation, and drilling) should not be initiated until a check for underground utilities and similar obstructions has been conducted. The use of as-built drawings must be confirmed with additional geophysical or other surveys.

Contact utility companies or the state/regional utility protection service at least 2 working days prior to excavation activities to advise of the proposed work, and ask them to establish the location of the utility underground installations prior to the start of actual excavation. Obtain utility clearances for subsurface work on both public and private property. Clearances are to be in writing and signed by the party conducting the clearance.

Protect and preserve the markings of approximate locations of facilities until the markings are no longer required for safe and proper excavations. If the markings of utility locations are destroyed or removed before excavation commences or is completed, the Project Manager must notify the utility company or utility protection service to inform them that the markings have been destroyed.

Mechanical-assisted subsurface work (e.g., powered drill rig or mechanical excavator) should not be conducted within 5 feet (1.5 meters) of a confirmed or suspected utility or other subsurface structure. Minimum distances for mechanical-assisted subsurface work should be confirmed with the utility owner, as distances beyond this 5-foot minimum may be required.

Subsurface work within 5 feet (1.5 meters) of a confirmed or suspected utility or other subsurface structure must be done by hand (e.g., hand auger or shovel) to the point where the

obstruction is visually located and exposed. Once the obstruction location is confirmed in this manner, mechanical-assisted work may commence.

If drilling operations are performed using a drilling rig with a mast, the mast will be kept a safe distance from any overhead power lines in accordance with URS SMS 34. No work is to be conducted within 50 feet (15 meters) of overhead power lines without first contacting the utility company to determine the voltage of the system. No aspect of any piece of equipment is to be operated within 50 feet (15 meters) of overhead power lines without first making this determination.

The CHSO will obtain all necessary permits and inspections required by local and state regulation (e.g., DigSafe) and will coordinate with the Fort Meade utilities department for the performance of activities with or around electrical utilities or below-grade drilling or excavation.

4.3.4 Drilling Safety

The drill rig operator will conduct pre-work inspections of all parts of the equipment in use in accordance with the Operator's Manual/Manufacturer's Specifications. Broken or inoperative parts will be repaired or replaced. Drilling personnel will use the designated PPE for the task. The operator and CHSO will ensure minimum clearance from overhead power lines.

All members of the drill crew must receive site-specific training prior to beginning work and must provide the appropriate documents and training certificates required of all site workers, such as the 40-hour HAZWOPER training certificate, medical monitoring reports, or operator's qualifications. The driller in charge must also provide the necessary proof of compliance with any specific regulation of the State of Maryland regarding the training and qualifications of drillers.

Drill rig safety and maintenance is the responsibility of the drill rig operator. Only qualified personnel will operate drilling rigs. Drilling rigs will not be operated in a manner that will endanger persons or property. All drill rigs will be operated in accordance with the manufacturer's instruction, OSHA 29 CFR 1926 Subpart O; Sections of 11.E, 16, and 18 of USACE 385-1-1; and URS SMS 56, Drilling Safety Guidelines.

The driller is responsible for the safe operation of the drill rig as well as the crew's adherence to the requirements of the SSHP. The driller must ensure that all safety equipment is in proper condition and is properly used. The members of the crew must follow all instructions provided by the manufacturer of the drill rig, wear the required PPE, and be aware of all hazards and control procedures. The drill crews must participate in the daily tailgate safety meeting and be aware of all emergency procedures.

4.3.5 Contact with Energized Sources

During any site activities that involve work around live utilities, a potential exists for personnel, heavy equipment, or moving vehicles to contact energized sources. Additionally, personnel could come in contact with energized parts of machinery or power tools. Contact with energized sources may result in fire, explosion, and/or electrocution. All work performed near electrical sources must be performed consistent with the OSHA electrical safety requirements found in 29

CFR 1926 Subpart K, Section 11 of USACE EM 385-1-1, and URS SMS 12, Electrical Safety, and URS SMS 34, Utility Clearance and Isolation (Attachment D).

Control efforts for this hazard include requirements that all equipment and power tools used on site be properly maintained, positioned, guarded, and operated by competent personnel. Equipment will not be permitted within a 20-foot radius of energized sources with nominal voltage less than 300 kV. For energy systems with nominal voltage greater than 300 kV, the distance required will be in accordance with OSHA 1926 Subpart K. A qualified electrician must perform site work involving electrical installation or energized equipment.

All electrical circuits and equipment must be grounded in accordance with the NEC regulations. The path to ground from circuits, equipment, and enclosures will be permanent and continuous. Ground fault circuit interrupters (GFCIs) are required on all 120-volt, single-phase, 15- and 20-amp outlets in work areas that are not part of the permanent wiring of the building or structure. A GFCI is required when an extension cord is used. GFCIs must be tested regularly with a GFCI tester. Portable generator frames do not require grounding when the cord and plug-connected equipment are connected through receptacles mounted on the generator.

Heavy-duty extension cords will be used; flat-type extension cords are not allowed. All extension cords must be the three-wire type and designed for hard/extra-hard usage. Electrical wire or cords passing through work areas must be protected from water and damage. Worn, frayed, or damaged cords and cables will not be used. Walkways and workspaces will be kept clear of cords and cables to prevent a tripping hazard. Extension cords and cables may not be secured with staples, hung from nails, or otherwise temporarily secured.

In existing installations, changes in the circuit protection (in order to increase the load in excess of the load rating of the circuit wiring) are not allowed. All circuits will be protected against an overload. All lamps used in temporary lighting will be protected from accidental contact and breakage. Metal shell and paper-lined lamp holders are not permitted. Fixtures, lamp holders, lamps, and receptacles are not permitted to have live parts. Workers must not have wet hands while plugging and unplugging energized equipment. Plugs and receptacles will be kept out of water (unless they are approved for submersion).

4.3.6 Noise

Noise is a potential hazard associated with the operation of heavy equipment, power tools, pumps, or generators. High-noise operations will be evaluated by the CHSO. As a general rule, site personnel will be required to wear hearing protection when working on or near heavy equipment, power tools, and generators. Noise control and hearing protection requirements will be implemented in accordance with 29 CFR 1910.95, Section 5C of USACE EM 385-1-1, and URS SMS 26.

4.3.7 Hand and Power Tools

All hand and power tools will be maintained in a safe condition and in good repair. Hand and power tools will be used in accordance with 29 CFR 1926, Subpart I, Section 13 of USACE EM 385-1-1, and URS SMS 16, Hand Tools and Portable Equipment. Neither URS nor its subcontractors will issue or use unsafe tools. All tools will be inspected, tested, and determined to be in safe operating condition prior to each use in accordance with the manufacturer's

instructions. Any tool that fails an inspection will be immediately removed from the site, or tagged with a “Do Not Use” sign until repaired.

Workers using hand and power tools, which are exposed to falling, flying, abrasive, or splashing hazards, will be required to wear PPE (refer to Section 7.0 for more details). Eye protection must always be worn when working on site. Additional eye and face protection, such as safety goggles or face shields, may also be required when working with specific hand and power tools. Workers using tools that may subject their hands to injuries, such as cuts, abrasions, punctures, or burns, will wear protective gloves. URS SMS 64 addresses Hand Safety. Workers will not wear loose or frayed clothes, dangling jewelry, or loose long hair when operating power tools.

Electric power-operated tools will be double-insulated or grounded, and equipped with an on/off switch. Guards must be provided to protect the operator and nearby workers from hazards such as nip points, rotating parts, flying chips, and sparks. All reciprocating, rotating, and moving parts of tools will be guarded if contact is possible. Workers are prohibited from removing machine guards.

4.3.8 Manual Lifting

Back injuries are among the leading occupational injuries reported by industrial workers. Back injuries such as pulls and disc impairments can be reduced by using proper manual lifting techniques. Leg muscles are stronger than back muscles, so workers should lift with their legs and not with their backs. If the load is too heavy, workers should not attempt to lift it alone. Lifting is always easier when performed with another person. Manual or mechanical assistance should always be used when it is available. Section 14A, USACE EM 385-1-1 and URS SMS 69 provides information on Manual Material Handling.

4.3.9 Temperature Extremes

Local weather conditions and the required use of PPE may produce an environment that will require restricted work schedules in order to protect employees from heat stress. The CHSO will be observing workers for any potential symptoms of heat stress. Adaptation of work schedules and training to recognize heat stress conditions should help prevent heat-related illnesses from occurring. Heat stress controls will be started at 70°F for personnel in protective clothing, and at 90°F for personnel in regular work clothing. Heat stress prevention controls include:

- Allow workers to become acclimatized to the heat (3 to 6 days);
- Provide shaded or air-conditioned break areas;
- Provide sun screen to prevent sun burn;
- Provide drinking water and electrolyte-replenishing fluids; and
- Monitor all workers wearing PPE for heat stress.

URS SMS 18 includes additional information on heat stress.

Cold stress may be a concern in the winter months. Warm rest areas and warm fluids should be available on site; personnel should wear appropriate clothing, with a change of clothing and raingear available when wet or damp conditions exist. Personnel must be aware of the signs and

symptoms of cold stress. Additional information is included in URS SMS 59. Section 6J, USACE EM 385-1-1 addresses Inclement Weather and Environmental Hazards.

4.3.10 Other Weather-Related Hazards

Other weather-related hazards include electrical storms, treacherous weather-related working conditions, or limited visibility. These hazards correlate with the season in which site activities occur. Outside work will be suspended during electrical storms. In the event of other adverse weather conditions, the CHSO will determine if work can continue without endangering the health and safety of site personnel.

4.3.11 Flammable and Combustible Materials

All flammable and combustible liquids will be stored outdoors at a location approved by the contractor, in a well-ventilated area, and away from excessive heat or direct sunlight. These liquids will not be stored in areas used for exits, stairways, or aisles. Material that reacts with water will not be stored near flammable or combustible liquids. All sources of ignition are prohibited in this area, including smoking, cutting and welding, hot surfaces, open flames, sparks (static, electrical, and mechanical), and frictional heat. Handling, storage, and use of flammable and combustible liquids will be in compliance with 29 OSHA CFR 1926.152, Section 9B of USACE EM-1385-1-1, and URS SMS 15, Flammable and Combustible Liquids and Gases. If flammable or combustible liquids are brought on site for use by URS personnel or its subcontractors, URS will acquire a copy of the MSDS prior to the use of the material on site.

4.3.12 Illumination

It is expected that site activities will be conducted only during daylight hours. Any lighting used will be weatherproof and intrinsically safe, and meet OSHA requirements, at a minimum. Refer to Table 7-1 in USACE 385-1-1 for minimum lighting requirements.

4.3.13 Vehicle Safety

Personnel must use caution when traveling to and from the site in personal or company vehicles. URS SMS 57 contains information on the corporate Vehicle Safety Program.

4.4 BIOLOGICAL HAZARDS

Biological agents that may cause health hazards are diverse; consequently, their health effects are also diverse. Biological hazards include bloodborne pathogens, microorganisms, insect-borne illnesses, and poisonous plants, insects, and spiders. The effects range from mild skin irritation to debilitating or life-threatening illness. Unfortunately, many biological agents are too small to be observed or arise from seemingly harmless sources. Section 6D, USACE EM 385-1-1 and URS SMS 47 contain information regarding harmful plants, animals, and insects.

4.4.1 Biting/Stinging Insects and Spiders

One type of poisonous spider may be present in this area: the brown recluse. The brown recluse spider is approximately 3/8-inch in size, with a dark, violin-shaped mark on its back. It weaves a sticky, irregular web. Within a few hours of being bitten, the victim's skin around the bite becomes red and swollen. In time, most of the tissue dies; leaving a deep sore that may take months to heal and may leave a scar. A few persons suffer an allergic reaction to the spider's poison that could result in death.

Personnel may also encounter a number of biting or stinging insects during site activities. Insects that may be present on site include chiggers, bees, wasps, mosquitoes, and ticks. The CHSO will inform personnel about the potential insect hazards and preventative measures, such as the use of insect repellant. If an insect bite or sting occurs, personnel trained in first aid procedures will administer first aid. Site workers who have a history of allergic reactions to bee stings should inform the CHSO using the Medical Data Sheet completed during the initial site-specific safety training. If there is an insect bite or sting emergency, the victim can be transported to the hospital for treatment.

West Nile virus is transmitted by infected mosquitoes. To avoid mosquitoes, do not plan field work for early morning or at dusk, when they are most active. To protect against bites, wear long sleeves and long pants, with pant legs tucked into or taped around socks. Spray clothing and exposed skin with a repellant containing diethyl-m-toluamide (DEET).

4.4.2 Bloodborne Pathogens

During site activities, workers can potentially be exposed to bloodborne pathogens when rendering first aid or CPR, or possibly from buried waste. Avoiding contact with biological agents is the best way to prevent adverse health effects caused by them. Recognition of potential hazards is essential. As a general rule, employees will not come into contact with any item in the waste debris that may appear to result from medical waste disposal. When avoidance is impractical or impossible, such as when administering first aid, PPE and personal hygiene will be used to prevent adverse effects.

Employees are at risk of contracting infectious diseases each time they are exposed to bloodborne pathogens. Any exposure incident may result in infection and subsequent illness. Since it is possible to become infected from a single exposure incident, it is the practice of URS to prevent exposure incidents whenever possible. To ensure employees are effectively informed concerning potential workplace health hazards, and in accordance with the requirements set forth in 29 CFR 1910.1030 and Section 3, USACE EM 385-1-1, URS has established an exposure control plan as part of URS SMS 51, Bloodborne Pathogens. The purpose of this plan is to identify those tasks and procedures where occupational exposure to bloodborne pathogens may occur, to identify the positions whose duties include those tasks, and to implement controls that will significantly reduce the risk of infection by bloodborne pathogens. The plan also includes provisions for affected employees to receive Hepatitis B vaccinations, training, and, if necessary, confidential medical evaluations and follow up.

4.4.3 Lyme Disease

Deer tick bites may result in the transmission of Lyme disease. A characteristic rash may develop a few days to a few weeks after the bite of an infected tick. The rash generally looks like an expanding red ring with a clear center, but it can vary from a blotchy appearance to red throughout the rash; however, it is important to note that some victims never exhibit a rash. Lyme disease symptoms include flu-like symptoms such as headache, stiff neck, fever, muscle aches, and/or general malaise. If Lyme disease is not treated early with antibiotics, the early symptoms may disappear, but more serious problems may follow. Long-term effects of Lyme disease may include arthritis of the large joints, meningitis, neurological complications (numbness, tingling in extremities, loss of concentration and memory retention, Bell's Palsy), withdrawal, lethargy, or cardiac symptoms. Personnel should use the following prevention tactics when working outside:

- Avoid walking through brush, woods, or grassy areas; try and avoid contact with plants if you must walk through these areas.
- Dress in light-colored clothing to make adhering ticks more visible. Wear long-sleeve shirts and tuck pants into or tape around socks.
- Use a tick repellant containing DEET. Spray onto clothing and exposed skin.
- Perform self-searches each day to check for ticks.

4.4.4 Poisonous Snakes

Fort Meade is located in a region of Maryland that may contain two species of *poisonous snakes*—the Timber Rattlesnake and the Northern Copperhead snake. The copperhead snake prefers rocky regions, and is inoffensive and not aggressive unless disturbed. Copperheads use rocks and timber piles for shelter and hibernate in burrows vacated by other animals. Its bite, while painful and capable of producing severe illness, rarely results in death. Site personnel should avoid rocks, timber piles, and animal burrows. Rattlesnakes usually attack only when they are surrounded or surprised, so site personnel should proceed slowly or avoid dense patches of underbrush. If a rattlesnake is encountered, back away *slowly*. Rattlesnake habitats include stump holes, animal burrows, and dense patches of underbrush.

The possibility of poisonous snakes will be communicated to site personnel during the initial site-specific safety training. Site personnel will be warned to avoid snakes, and will be required to wear sturdy steel-toe/steel-shank work boots. If there is a snakebite emergency, the victim will be transported to the hospital for emergency treatment.

4.4.5 Poisonous Plants

Poison ivy, oak, and sumac may be present on site. Poison ivy can be found as vines on tree trunks or as upright bushes. Poison oak is another name for the bush form of poison ivy. Poison ivy consists of three leaflets with notched edges—two leaflets form a pair on opposite sides of a stalk, and the third leaflet stands by itself at the tip. Poison ivy is red in the early spring and turns shiny green later in the spring. Poison sumac can be present in the form of a flat-topped shrub or tree. It has fern-like leaves, velvety dark green on top and pale underneath. The branches of immature sumac have a velvety “down.” Poison sumac also has “hairy” berry clusters.

Contact with poison ivy, oak, or sumac may lead to a skin rash, characterized by reddened, itchy, blistering skin that needs first aid treatment. If you believe you have contacted one of these plants, immediately wash your skin thoroughly with soap and water, taking care not to touch your face or other parts of your body prior to washing. In addition, wash contaminated clothing in strong soap and water, because the plant oils can remain active for a period of months.

Table 5-1 contains the Job Hazard Analyses (JHA) for the tasks scheduled for the RI. The JHAs will be reviewed and discussed by all site workers involved with the specific task prior to the start of the task. The initial JHA review will be documented by the CHSO.

The JHAs are as follows:

- Direct-push soil and groundwater sampling

Additional JHAs will be developed for additional tasks as the need arises.

TABLE 5-1
JOB HAZARD ANALYSIS

Activity: **Collection of soil/groundwater samples using direct-push**

PRINCIPAL STEPS	POTENTIAL HAZARDS	RECOMMENDED CONTROLS
1. Establish an Exclusion Zone. 2. Drill soil boring. 3. Collect soil/groundwater samples at desired intervals	1. Contact with underground or overhead utilities 2. Exposure to volatilizing site contaminants, excessive dust. 3. Muscle strain from lifting heavy items. 4. Slips, trips, or falls. 5. Head injury. 6. Eye injury. 7. Physical impact or injury from hand tools, heavy equipment, or moving loads. 8. Rotating equipment 9. Drill rig toppling 10. Cathead rope and operations 11. Excessive noise exposure due to drilling operation. 12. Biological hazards.	1. Utility clearance will be confirmed before any drilling begins. 2. Initially wear Level D PPE. Level D consists of hard hat, safety glasses, steel-toed boots or shoes, work gloves, and hearing protection, as needed. Upgrade to Modified Level D (Tyvek coveralls, chemical resistant gloves) when conducting intrusive activities. Upgrade to Level C if action levels for organic vapors/ total dust are exceeded. 3. Do not wear loose clothing or jewelry when operating drill rig; inspect kill switches and make sure they are easily accessible; do not touch while rotating. 4. Make sure drill rig is properly jacked and stabilized. 5. Inspect cathead rope to make sure it is in good condition; keep rope tangle free; operate on level surface with firm footing; do not operate when wet – operate with extreme caution 6. Keep walking surfaces free from slipping or tripping hazards. 7. Keep unnecessary personnel away from the area during drilling activities. 8. Arrange traffic flow to avoid personnel crossing the route of drilling equipment 9. Equipment operators should look in the direction of their travel; look before backing up. 10. Use proper lifting techniques; get assistance or use mechanical aids. 11. Awareness of biological hazards; use of repellant for ticks, mosquitoes, insects; tick checks.

Continued on next page

TABLE 5-1 (Continued)
JOB HAZARD ANALYSIS

Activity: **Collection of soil/groundwater samples using direct-push**

EQUIPMENT TO BE USED	INSPECTION REQUIREMENTS	TRAINING REQUIREMENTS
1. Drill rig 2. Photoionization detector 3. Real-time dust monitor 4. Hand tools 5. PPE	1. Inspect drilling equipment daily for function of safety features and operating parts (drill rig operator). 2. Calibrate/inspect monitoring equipment. 3. Inspect hand tools for excessive wear and loose parts. 4. Inspect area for underground utility clearance in conjunction with property owner. 5. Inspect PPE for damage, excessive wear	1. Initial 40-hour HAZWOPER and current 8-hour refresher 2. Drill rig operator training 3. Monitoring equipment operation 4. Hearing Conservation Program 5. Respiratory Protection Program 6. PPE Program

TABLE 5-1
ACTIVITY-HAZARD ANALYSIS

Activity: **Excavation of Test Pits**

PRINCIPAL STEPS	POTENTIAL HAZARDS	RECOMMENDED CONTROLS
1. Establish an Exclusion Zone. 2. Carefully excavate soil to desired depth. 3. Field screen excavated soil with OVM. 4. Monitor excavation with CGI. 5. Sample excavation at desired intervals. 6. Stockpile soil on plastic sheeting. 7. Cover soil stockpiles with plastic sheeting and anchor it. 8. Barricade edges of excavation until it is backfilled. 9. Backfill excavation once approval is granted.	1. Exposure to volatilizing site contaminants, excessive dust. 2. Exposure to medical waste (sharps, glass, etc.) 3. Contact with underground utilities. 4. Personnel caught in excavation cave-in or falling into excavation. 5. Roll heavy equipment into excavation. 6. Muscle strain from lifting heavy items. 7. Slips, trips, or falls. 8. Physical impact or injury from hand tools, heavy equipment, or moving loads. 9. Excessive noise exposure due to heavy equipment or power tool use. 10. Potential explosive atmosphere; generation of sparks, flame, or static electricity may cause an explosion.	1. Utility clearance will be confirmed before any excavation begins. 2. Initially wear Level D PPE (including chemical resistant gloves). Upgrade to Modified Level D (Tyvek coveralls) if contact with contaminated soil or materials is expected. Upgrade to Level C if action levels for organic vapors are exceeded or if dust levels cannot be controlled using wet methods. 3. Work upwind and perform air monitoring for organic vapors, radiation and combustible gases. 4. Stop work if CGI indicates >10% LEL 5. Keep area free of ignition sources. 6. Any excavations deeper than 4 feet are also considered to be a confined space. Personnel will not enter the excavation. 7. Personnel will not stand, work, or travel beneath loads handled by lifting or excavating equipment. 8. Keep walking surfaces free from slipping or tripping hazards. 9. Keep unnecessary personnel away from the area during excavation activities.

Continued on next page

TABLE 5-1 (Continued)
ACTIVITY-HAZARD ANALYSIS

Activity: **Excavation of Test Pits**

RECOMMENDED CONTROLS		
10. A warning system will be used if mobile equipment is operated or is adjacent to the excavation. The warning system may consist of barricades, hand or mechanical signals, or stop logs. 11. Arrange traffic flow to avoid personnel crossing the route of excavation equipment. 12. Provide hearing protection. 13. Follow proper lifting techniques. 14. Equipment operators should look in the direction of their travel; look before backing up.		
EQUIPMENT TO BE USED	**INSPECTION REQUIREMENTS**	**TRAINING REQUIREMENTS**
1. Backhoe 2. Organic Vapor Meter 3. Combustible Gas Indicator 4. Ionizing Radiation Survey Meter 5. Shovels, other hand tools 6. Plastic sheeting, sandbags	1. Inspect heavy equipment daily for function of safety features (e.g., horn, back-up alarm, etc.) and general assembly (e.g., missing parts, loose hoses, etc.). 2. Calibrate/inspect monitoring equipment. 3. Inspect hand tools for excessive wear and loose parts. 4. Inspect area for underground utility clearance in conjunction with property owner. 5. Inspect excavation daily, prior to start of work, in accordance with OSHA Standard 1926 Subpart P.	1. HAZWOPER 2. Heavy equipment operator training 3. Monitoring equipment operation 4. Excavation Safety Program 5. Hearing Conservation Program 6. Respiratory Protection Program 7. PPE Program

TABLE 5-1
ACTIVITY-HAZARD ANALYSIS

Activity: **Collection of soil samples from excavation**

PRINCIPAL STEPS	POTENTIAL HAZARDS	RECOMMENDED CONTROLS
From excavation: 1. Backhoe operator collects a bucket full of soil from designated location in bottom or sidewall of excavation. 2. Bucket of soil is lifted to surface of excavation. 3. Screen soil sample with OVM. 4. Sampling personnel fill appropriate sample bottles with soil from the backhoe bucket. 5. Dispose of or decontaminate sampling equipment. From soil stockpile: 1. Use a hand-auger or trowel to dig a hole at least 6 inches deep. 2. Remove underlying soil. 3. Place soil in appropriate sample bottles. 4. Dispose of or decontaminate sampling equipment	1. Contact with contaminated material. 2. Exposure to volatilizing site contaminants. 3. Fall into excavation. 4. Slips, trips, or falls on uneven or unstable soil. 5. Struck by backhoe bucket. 6. Muscle strain from hand-auger use.	1. Wear Level D PPE (including chemical resistant gloves). If contact with contaminated material is likely, upgrade to Modified Level D (Tyvek coveralls). 2. Perform air monitoring for organic vapors. 3. Perform sampling of excavation at least 2 feet away from edge of excavation. 4. Personnel will not enter any excavations to collect soil samples. The soil to be sampled will be brought out of the excavation via backhoe bucket. 5. Sampling personnel stand clear of backhoe bucket; move in to collect soil samples after operator rests bucket on ground surface. 6. Follow proper lifting and digging techniques. 7. Avoid climbing on the soil stockpile.
EQUIPMENT TO BE USED	**INSPECTION REQUIREMENTS**	**TRAINING REQUIREMENTS**
1. Organic Vapor Meter 2. Backhoe 3. Hand auger, shovels, trowels 4. Sample bottles	1. Calibrate air monitoring equipment. 2. Inspect hand tools for excessive wear and loose parts. 3. Inspect heavy equipment daily for function of safety features (e.g., horn, back-up alarm, etc.) and general assembly (e.g., missing bolts, loose hoses, etc.) 4. Inspect excavation area daily in accordance with OSHA Standard 1926 Subpart P.	1. HAZWOPER 2. Monitoring equipment operation 3. PPE Program 4. Heavy equipment operation 5. U.S. DOT Training for shipment of environmental samples

TABLE 5-1
ACTIVITY-HAZARD ANALYSIS

Activity: **Collection of surface water and sediment samples**

PRINCIPAL STEPS	POTENTIAL HAZARDS	RECOMMENDED CONTROLS
1. Collect sample 2. Place sample in appropriate sample bottle	1.Contact with contaminated material. 2.Exposure to volatilizing site contaminants. 3.Exposure to bacteria, viruses 4.Slips, trips, or falls	1. Wear Level D PPE (including safety glasses/goggles, chemical resistant gloves and rubber overboots/waders, as needed). If contact with contaminated material is likely, upgrade to Modified Level D (Tyvek coveralls). 2. Perform air monitoring for organic vapors, as needed. 3. Use caution when walking on slippery surfaces or wading into streams/standing water.
EQUIPMENT TO BE USED	**INSPECTION REQUIREMENTS**	**TRAINING REQUIREMENTS**
1. Organic Vapor Meter 2. Sampling equipment (bailers, etc.) 3. Sample bottles	1.Calibrate air monitoring equipment.	1.HAZWOPER 2.Monitoring equipment operation 3.PPE Program 4. U.S. DOT Training for shipment of environmental samples

6.1 COMMUNICATIONS

A cellular phone will be available on site for emergency use. Emergency numbers are posted in Table 10-1 and will be available on site. Work will not be conducted on site without access to a telephone, and site personnel will be informed of the nearest available telephone. Two-way radios may be used for communications among personnel performing site work.

6.2 GENERAL SITE RULES

- All site personnel will wear PPE as required by the task. Refer to the applicable Job Hazard Analysis (JHA) (Section 5.0) for task requirements.
- The buddy system will be observed at all times.
- Facial hair that interferes with a respirator-to-face seal will not be permitted on site personnel required to wear respiratory protection.
- Entry into excavations is not permitted.
- All site personnel who wear corrective lenses will provide their own prescription safety glasses and respirator optical inserts.
- Horseplay will not be tolerated.
- Matches and lighters are not permitted in any confined space.
- Proper site housekeeping (including removal of trash and orderly stacking and removal of materials to reduce slipping, tripping, and fire hazards) will be the responsibility of all site personnel on a daily basis.
- If any unusual site conditions are noted (odors, presence of unknown liquids, suspect biohazards) or any symptoms are experienced, work will be stopped until site hazards can be evaluated.

6.3 SANITATION

Sanitation facilities will be set up or maintained in accordance with 29 CFR 1926.5, Section 2.0 of USACE EM 385-1-1, and URS SMS 30, Sanitation. Sanitation issues will include the following:

- Drinking/potable water
- Toilets
- Showering facilities and change rooms
- Food service/eating and drinking areas
- Waste disposal
- Vermin control

7.1 GENERAL

URS SMS Form 29-1, Personal Protective Equipment (Attachment B), has been used as part of the PPE decision-making process. The level of protection worn by site personnel will be enforced by the CHSO. Levels of protection may be upgraded or downgraded at the discretion of the RHSEM, based on real-time air monitoring data and prior site experience. Any changes in the level of protection will be documented. Initial levels of protection assigned for each task are outlined in the applicable JHA for that task (Section 5.0). Levels of protection less than those designated in the applicable JHA must first be approved by the HSER or RHSEM.

In the event that site monitoring detects organic vapors above action limits specified in Section 8.1, or if dust levels cannot be controlled using wet methods, appropriate respiratory protection will be donned. Respirator use will be in accordance with the requirements of 29 CFR 1910.134 and URS SMS 42.

7.2 LEVEL D PROTECTION

Level D PPE provides minimal protection against chemical hazards, and should not be worn in any area with respiratory or skin hazards. A respirator is not required. Level D PPE will be worn for general site work (non-intrusive activities) and includes:

- Cotton coveralls or long pants and a shirt with sleeves
- Hard hat
- Safety glasses
- Steel-toe/steel-shank work boots
- Work gloves for materials handling; latex/nitrile gloves for sample collection
- Hearing protection (as required)
- Rubber overboots/waders (as required)

7.3 MODIFIED LEVEL D PROTECTION

Modified Level D PPE includes the items listed in Section 7.2 above, *and a selection of one or more* of the following items:

- Regular (white) or poly-coated tyvek (yellow) or PVC rain suit
- Safety goggles/face shield
- Chemical-resistant over-boots or chemical resistant steel-toe/steel shank boots
- Inner latex (i.e., surgical) gloves
- Chemical-resistant outer gloves **(type – nitrile rubber)**
- Tape for sealing arm, leg, and zipper joints

Modified Level D PPE will be donned when conducting intrusive activities for protection against chemical hazards.

7.4 LEVEL C PROTECTION

Level C PPE provides a higher level of respiratory and skin protection against chemical hazards. Level C PPE will be worn if action levels are exceeded; it includes the items listed in Section 7.2 above and the following items:

- Regular (white) or poly-coated tyvek (yellow)
- Steel-toe/steel-shank work boots and latex over-boots, or chemical-resistant steel-toe/steel shank boots
- Inner latex (i.e., surgical) gloves
- Chemical-resistant outer gloves **(type – nitrile rubber)**
- Tape for sealing arm, leg, and zipper joints, as required
- Full-face, air-purifying respirator equipped with appropriate cartridges (organic vapor cartridges with P100 filters, at a minimum)

7.5 LEVEL A AND B PROTECTION

Level A PPE should be worn when the highest level of respiratory and skin protection is needed, or if the contaminants of concern are unknown. Level B PPE should be worn when the highest level of respiratory protection is required, but a lesser level of skin protection is needed. The tasks scheduled for this project should not require the use of Level A or B PPE, and their use is not covered by this SSHP.

Heat stress, noise, and chemical exposure may be encountered at this site. Heat stress monitoring and prevention is addressed in Section 5.2.1. Noise levels will not be monitored; URS personnel will wear hearing protection as described in Section 7.0.

8.1 CHEMICAL EXPOSURE MONITORING

The field instrumentation described in this SSHP has been specifically selected for the contaminants that may be reasonably anticipated to be encountered during the course of this project. Selection factors include anticipated airborne concentrations, potential interference, ionization potentials, instrument sensitivity, and occupational exposure limits.

Based on the site history summarized in Sections 1.2 and 4.2, pesticides and metals may be present in the soil. While the exposure limits are expressed in milligrams per cubic meter (mg/m^3), many of the pesticides and herbicides have an organic component. Thus, these analytes may present an inhalation hazard from contaminated dust and organic vapors, and a monitoring program will be initiated.

The monitoring equipment specified in this section will be used on a regular basis to evaluate the potential for exposure to airborne contaminants, typically every 5 to 10 minutes. Monitoring for total organic vapor concentrations will be performed using a photo ionization detector (PID) with an 11.8 eV bulb. Monitoring for total dust concentrations will be conducted using a direct-reading instrument.

Monitoring will be conducted in the immediate vicinity of the contaminant source point or work area and in the breathing zone of potentially exposed workers. Action levels are set as described below.

Table 8-1. Action Levels and Response Criteria

Analyzer Reading	Location	Duration	Action	Personal Protective Equipment
PID <5 ppm Real-time dust monitor <10 mg/m^3	OBZ OBZ	_____	Continue periodic monitoring.	Modified Level D -hardhat, steel-toed boots, eye protection, Tyvek coverall with attached booties or overboots. Nitrile outer gloves and nitrile inner (surgical) gloves when collecting samples; work gloves when handling equipment/ materials; hearing protection as needed.
PID >5 ppm above background OR Dust monitor >10 mg/m^3	OBZ OBZ	>5 minutes >5 minutes	Don respirators; establish work zones and decon area; continue periodic monitoring.	Level C – PPE listed above plus full-face air purifying respirator with organic vapor cartridges/P100 filters
PID >125 ppm OR >250 ppm	OBZ OBZ	>5 minutes instantaneous	Stop work; move upwind while vapors dissipate. If elevated levels remain, evacuate upwind and notify RHSM or PM.	As specified by RHSM

Work will be stopped if any unusual conditions are encountered (odors, suspect liquids) or if personnel experience any symptoms associated with potential exposure to the contaminants of concern. Site conditions and the need for additional PPE or site controls will be re-evaluated prior to resuming work.

The dust site action level (AL) was based on the following calculation, using arsenic as the example chemical. This compound was one of the chemicals reported as having the highest concentrations during the last sampling event, and has the lowest exposure limit of those reported chemicals.

$$\text{Site AL} = \frac{\text{Exposure limit x units correction}}{\text{Soil concentration x safety factor}} = \frac{0.01\ \text{mg/m}^3 \times 10^{-6}\ \text{kg/mg}}{56\ \text{mg/kg} \times 10} = 18\ \text{mg/m}^3$$

Even using a conservative safety factor of 10, which was selected due to the toxic nature of the suspect contaminants, controlling the dust concentration to the American Conference of Governmental Industrial Hygienists (ACGIH) Threshold Limit Value (TLV) of 10 mg/m^3 for total dust should maintain contaminants within acceptable levels.

8.2 COMBUSTIBLE GAS MONITORING

It is not anticipated that a Combustible Gas Monitor will be required during this sampling event.

8.3 HEAT/COLD STRESS MONITORING

Whenever the air temperature exceeds 70°F for personnel wearing chemical-protective clothing or 90°F for personnel wearing regular work clothes, the CHSO will assess conditions that may cause heat stress in site workers. The CHSO will follow procedures identified in URS SMS 18 (Attachment D) to determine the length of the work/rest cycle.

Prevention of cold stress is a function of whole body protection. Adequate insulated clothing will be worn when the air temperature drops below 40°F. Reduced work periods may be necessary in extreme conditions to allow adequate rest periods in a warm area. Other cold stress prevention controls include:

- Changing clothes when work clothes become wet with sweat;
- Avoiding caffeine (which has diuretic and circulatory effects); and
- Ensuring workers drink warm, sweet drinks or soups to increase their caloric intake and reduce the possibility of cold weather dehydration.

Additional information on cold stress is included in URS SMS 59.

9.1 CONTAMINATION PREVENTION

One of the most important aspects of decontamination is the prevention of contamination. Good contamination prevention should minimize worker exposure. During the use of hazardous chemicals or when potentially contaminated materials (e.g., groundwater or soil) are encountered, contamination prevention protocols will be implemented. Procedures for contamination prevention for personnel include:

- Do not handle or touch contaminated materials directly.
- Make sure all PPE is free of cuts or tears prior to donning.
- Fasten all closures on suits, covering with tape if necessary.
- Take special care to protect any skin injuries. If open wounds exist on hands or forearms, handling chemicals should be restricted or eliminated.
- Stay upwind of the chemical handling area.
- Do not carry cigarettes, gum, chewing tobacco, or cosmetics into the chemical handling area.

9.2 PERSONNEL DECONTAMINATION

All personnel handling hazardous chemicals will pass through a decontamination station, where conditions necessitate. To reduce the volume of water generated through decontamination protective clothing will be discarded, instead of cleaned and reused. The generation of decontamination water should be minimized whenever possible. The following steps outlined in Table 9-1 will be taken for personnel decontamination when exiting the chemical handling area. The decontamination setup is subject to modification by the CHSO.

Equipment and supplies needed for the personnel decontamination station include:

- Plastic buckets for glove wash and rinse;
- Plastic sheeting;
- Wash tubs for boot wash and rinse;
- Detergent/water solution (non-phosphate detergent);
- Long-handled soft-bristle scrub brushes for boot wash;
- Small, soft-bristle scrub brushes;
- Respirator sanitizer/cleaner (as needed); and
- Plastic trash bags.

STEP	TABLE 9-1 PERSONNEL DECONTAMINATION PROCEDURE
1	Deposit all used equipment and tools onto plastic sheeting or into plastic-lined containers.
2	Scrub outer boots and any soiled PPE (i.e., outer gloves and tyvek) thoroughly with a soapy wash solution and a scrub brush. Rinse off boots and PPE.
3	Remove tape from around boots and sleeves and dispose of into a plastic-lined drum.
4	Remove tyvek (inside out) and dispose of into a plastic-lined drum.
5	Remove outer over-boots and dispose of into a plastic-lined drum.
6	Remove outer gloves and dispose of into a plastic-lined drum.
7	Remove respirator (if required; refer to JHA) and clean respirator.
8	Remove inner gloves (inside out) and dispose of into a plastic-lined drum.
9	Precede to the site's sanitation facilities to thoroughly wash face, neck, hands, and forearms prior to eating, drinking, smoking, or using the restroom.

9.3 EQUIPMENT DECONTAMINATION

All equipment and tools will be cleaned prior to site entry to remove grease, oil, dirt, or any other off-site materials. An inspection of the equipment will be made by the SM prior to approving the items for use on site. The SM will also be responsible for inspecting all items for adequacy of decontamination prior to removal off site. It is not anticipated that site activities will cause contamination of large equipment; however, small tools and sampling equipment may require decontamination. The following steps outlined in Table 9-2 will be taken when decontaminating small equipment. Refer to the Work Plan for sampling equipment decontamination procedures.

STEP	TABLE 9-2 EQUIPMENT DECONTAMINATION PROCEDURE
1	Place all equipment in 6-mil plastic bags or wrap in plastic sheeting.
2	Scrub equipment with soapy water, using brushes and a phosphate-free soap.
3	Rinse equipment with potable water.
4	Rinse with acid, if necessary
5	Place equipment on clean plastic sheeting and allow drying.
6	Dispose of decontamination water as indicated in Section 9.4.

9.4 DISPOSITION OF DECONTAMINATION WASTE

PPE that may have come in contact with contaminated media will be decontaminated with phosphate detergent and rinsed with potable water. The rinse water will be collected in 5-gallon buckets and transferred to drums used to containerize purge water from the well. The used and decontaminated PPE will then be collected in plastic trash bags and disposed of as regular trash.

10.1 GENERAL

When an emergency occurs, decisive action is required. Decisions must often be made immediately and personnel must be ready to respond immediately to an emergency. For this purpose, pre-emergency planning is an essential part of each project's Emergency Action Plan. Pre-emergency planning tasks will be developed and established prior to the start of site work. Pre-emergency planning for the site includes the following tasks:

- Development and approval of this Emergency Action Plan in accordance with URS SMS 3, Emergency Action Plans
- Coordination of the Emergency Action Plan with local health and emergency response agencies
- Training of site personnel in appropriate emergency procedures
- Maintaining emergency response equipment on site, such as fire extinguishers, first aid supplies, and spill response equipment
- Conducting an emergency response practice drill during site mobilization and before site activities begin
- Modification of the Emergency Action Plan, if necessary, as work progresses

10.2 RESPONSE PRIORITIES

It is expected that URS personnel would provide minimal or first line response to all emergencies.

First Priority: Prevent further injury or illness by:

- Protecting response personnel;
- Isolating the scene to authorized personnel only;
- Notifying emergency response personnel; and
- If possible, rescuing any injured parties.

Second Priority: Provide first aid to persons with life-threatening injuries or illnesses.

Third Priority: Alleviate the immediate hazards by:

- Extinguishing incipient-stage fire,
- Reducing chemical releases, and/or
- Containing any spill.

10.3 EVACUATION ROUTES AND PROCEDURES

In a severe emergency such as a large fire, explosion, or large chemical release, site evacuation may become necessary. The CHSO will be responsible for informing site personnel of the anticipated routes of evacuation during the morning safety briefings. The evacuation route and

assembly area will correlate to the wind direction, topography, and the nature of the incident. Personnel will be advised to move to an upwind location at least 100 yards from any fires and/or releases, and will be advised to continually monitor wind direction for changes.

If moving upwind is not possible without encountering the incident, personnel will be advised to move crosswind or downwind to a distance out of the path of vapor releases, smoke, odors, or spills. In the event that a site evacuation becomes necessary, the following procedures will be used:

STEP	SITE EVACUATION PROCEDURES
1	Site personnel are notified of an emergency evacuation via horn signal or verbal command. All site personnel will immediately stop work.
2	All site personnel evacuate the work area as quickly as possible and assemble at a location at least 100 yards upwind of the incident, or as instructed during the morning safety briefing.
3	The CHSO will be responsible for roll call.
4	The CHSO will contact emergency response personnel as all site personnel are being accounted for during roll call.
5	The CHSO will ensure that emergency apparatus have adequate site access.
6	The CHSO will ensure that all combustion equipment has been shut down.
7	All site personnel assembled at the designated safe evacuation area will wait for further instructions from emergency response personnel.

10.4 INJURY/ILLNESS TREATMENT

In the event of any illness or injury, the following steps will be taken:

- Evaluate the extent of injuries or seriousness of illness.
- When employees require urgent medical attention, transport to the hospital or call for emergency assistance. First aid should be administered while awaiting an ambulance or paramedics. All emergency medical treatment, other than first aid, will be administered by the local paramedics. Table 10-1 lists site emergency telephone numbers. In all cases, critical injuries must be immediately referred for professional medical attention.
- All first aid will be administered by on-site personnel trained and certified in CPR and first aid. All vehicles used to transport injured persons to the off-site medical facility will be provided with directions and a map to the medical facility. Medical Data Sheets (completed during the initial site-specific safety training) will be referenced in an emergency to assist with the treatment of the victim. The CHSO will accompany the victim to the hospital.
- For a non-critical injury/illness, provide first aid treatment and evaluate the need for further treatment by either utilizing the services of the URS Occupational Health Specialist (OHS) or the URS Corporate Medical Consultant, who can be accessed through the OHS.

- Refer to URS SMS 65, Injury Management, which details procedures for pre- and post-injury management, including provisions for emergency and non-emergency injury/illness treatment, and workers' compensation case management.
- Prior to leaving the work site to seek treatment for a non-emergency injury or illness, URS personnel must obtain a signed referral form from their supervisor or the site manager. In the state of Maryland, the employee may choose the medical provider. In some cases, it may be necessary to identify a medical provider approved by the URS workers' compensation insurance carrier. If needed, a list of clinics/providers approved by the URS Workers Compensation Insurance carrier is available in each URS office. URS Health and Safety staff and the OHS will assist employees and managers as needed.

TABLE 10-1 EMERGENCY TELEPHONE NUMBERS	
Ambulance Service:	911
Fire: Fort Meade Fire Department	911 or (301) 677-2117
Police: Fort Meade Military Police	911 or (301) 677-6622
Hospital: Laurel Regional Hospital 7300 Van Dusen Road, Laurel, MD	Main number: (301) 725-4300
National Spill Response Center (refer to Section 10.10)	(800) 424-8802
Poison Control Center: National	(800) 222-1222
WorkCare (URS Medical Consultant): Dr. Peter Greaney	(800) 455-6155
Federal OSHA Hot Line (refer to Section 11.4)	(800) 321-6742
THE FOLLOWING PEOPLE WILL BE NOTIFIED IF AN INCIDENT HAS OCCURRED:	
URS Regional Health, Safety, and Environment Manager: Brian Klenk, CIH CSP	Work: (301) 721-2260 Cell (928) 600-9237
URS Health, Safety, and Environment Representative Patsy Glinsmann, CIH	Work: (301) 670-3332 Cell: (202) 210-5056
URS Occupational Health Specialist: Jeanette Schrimsher, RN, COHN	Work: (512) 419-5440 Toll free: 1-866-326-7321
Project Manager: Jerry Kashatus	Work: (301) 670-3375
Task Leader: Mark Cecchini	Work: (301) 721-2296
URS Site CHSO: Mark Cecchini	Cell: (413) 575-1908
EMO Authorized Representative: Kimberly Gross	Work: (410) 962-6735
URS Office: Gaithersburg, MD	(301) 258-9780

10.5 ROUTE TO LAUREL REGIONAL HOSPITAL

ROUTE TO LAUREL REGIONAL HOSPITAL FROM SUSPECT SITES	
1	Take Mapes Road west and proceed through the gate.
2	Cross MD Route 32, stay to the right and road becomes MD Route 198, Laurel Road.
3	Proceed on MD Route 198 approximately 5 miles through Laurel.
4	Turn LEFT onto Van Dusen Road.
5	Laurel Hospital is at 7300 Van Dusen Road before the intersection of Contee Road.

Approximate travel time/distance from the site to the hospital is 20 minutes/11 miles. Figure 10-1 maps the route to the hospital.

The URS Emergency Physician Access Plan, as shown on Table 10-2, may be instituted by the CHSO and/or the medical facility when emergency medical advice is required.

10.6 CHEMICAL EXPOSURE

TYPE OF OVER EXPOSURE	FIRST AID GUIDELINES
Skin Contact	Skin: Wash/rinse the affected area thoroughly with copious amounts of soap and water.
	Eyes: Eyes should be rinsed for at least 15 minutes following chemical contamination.
	Contact emergency response personnel if required, or transport victim to the hospital.
Inhalation	Move the victim to fresh air.
	Contact emergency response personnel if required, or transport victim to the hospital.
Ingestion	Contact Poison Control Center.
	Contact emergency response personnel, or transport victim to the hospital.

Figure 10-1: Route to Hospital

Laurel Regional Hospital, 7300 Van Dusen Rd, Laurel MD 20707-9266, phone: 301-725-4300

Part 1

Part 2

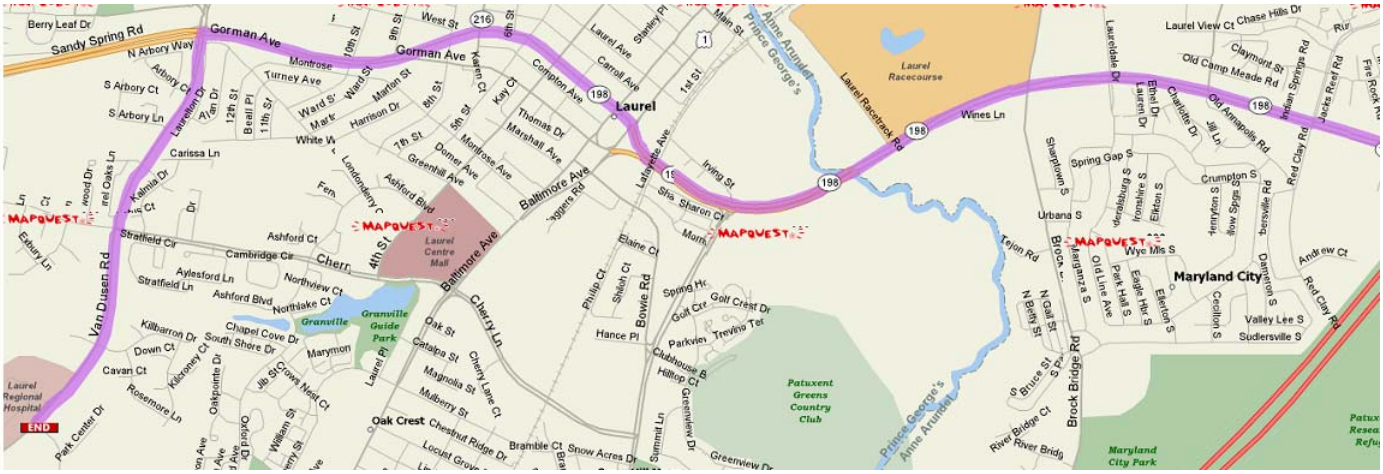

TABLE 10-2
EMERGENCY PHYSICIAN ACCESS PLAN

In the event that any medical emergency arises due to work-related injuries or illnesses, a 24-hour Emergency Physician Access Plan has been established to enable URS employees to communicate with our MC, Dr. Peter Greaney. The following procedure outlines how the Plan can be accessed during business hours:

STEP	MONDAY THROUGH FRIDAY, 9:30 a.m. - 8 p.m., EST
1	Contact the URS Medical Consultant at (800) 455-6155.
2	Give the receptionist the following information: ▪ You are calling for URS; and ▪ This is an emergency call.

The MC's staff has been informed how to contact the MC designated to provide emergency coverage on that day. *Collect calls will be accepted.*

The following procedure outlines how the Plan can be accessed during evenings, weekends, and holidays (non-business hours):

STEP	EVENINGS (after 8 p.m. until 9:30 a.m., EST), WEEKENDS, AND HOLIDAYS
1	Contact the URS MC at (800) 455-6155. An operator from the answering service will answer the telephone.
2	Give the answering service operator the following information: ▪ You are calling for URS; ▪ This is an emergency call; ▪ Give the operator your name; and ▪ Give the operator the telephone number where the MC can contact you (including your area code).
3	Verify the operator has written the correct telephone number; do not hang up first.
4	If you do not receive a call back from the MC within 15 minutes, place a second call to (800) 455-6155.

10.7 DECONTAMINATION DURING A MEDICAL EMERGENCY

As previously indicated, few site operations will trigger contamination of any type. For minor medical problems or injuries, regular decontamination procedures will be followed. If emergency, life-saving first aid and/or medical treatment are required, regular decontamination procedures may need to be abbreviated or omitted:

- ***If the victim has been contaminated with acid, other chemicals, or contaminated groundwater or soil:*** immediately wash or rinse the victim with water to rinse off the material.
- Outer garments can be removed if it does not cause a delay, interfere with treatment, or aggravate the problem.
- PPE can be cut away, and respiratory protective equipment must always be removed.
- If contaminated clothing cannot be safely removed, then the victim should be wrapped in a blanket or plastic sheeting to prevent the contamination of the inside of the ambulance and/or emergency response personnel.

The CHSO will advise the medical staff of the type of contamination.

10.8 SMALL/INCIPIENT FIRE

A small fire is defined as a fire that can be extinguished with an available 20-pound ABC fire extinguisher. An incipient fire is a fire that is small because it has just started. In the event of a small or incipient fire, the following minimum actions will be taken:

- Evacuate nearby personnel from the area, if possible, to an upwind location, or to an area not affected by smoke or hazardous decomposition products if an upwind location is not feasible.
- Attempt to extinguish fire using portable fire extinguisher or by smothering.
- Contact emergency response personnel, as needed, for any injuries or exposures to hazardous decomposition products.
- After the fire has been extinguished, or emergency response personnel have been contacted, notify the PM, RHSEM, and the EMO Authorized Representative.

10.9 LARGE FIRE/EXPLOSION

An explosion, large fire, or a small fire that cannot be extinguished is beyond the first line capabilities of URS personnel. Professional emergency response personnel would be needed to provide emergency assistance for these types of incidents. In the event of a large fire, explosion, or a small fire that cannot be extinguished, the following minimum actions will be taken:

- Evacuate all personnel from the site, if possible, to an upwind location, or to an area not affected by smoke or hazardous decomposition products if an upwind location is not feasible.
- Perform a quick roll call to account for all site personnel.
- Contact the fire department.

- Contact emergency response personnel, as needed, for any injuries or exposures to hazardous decomposition products.
- After emergency response personnel have been contacted, notify the PM, RHSEM, and the EMO Authorized Representative.

10.10 HAZARDOUS SUBSTANCE SPILL OR RELEASE

Hazardous substance spill or release situations may all be different due to the way the incident occurs, how hazardous the substance may be, and how much has been spilled or released. If a hazardous substance spill or release occurs, the following steps will be taken:

- Evacuate site personnel, if necessary. Follow the evacuation sequence outlined in Section 10.3.
- Determine the source of leak or release.
- Determine the approximate volume of the leaked or released substance, and identify the contaminants involved.
- Contact emergency response personnel to inform them of the possible need for assistance.
- Don the appropriate PPE.
- Secure the spread of the spill, if possible, using one of the following methods of containment:
  - Patch and plug
  - Sorbent materials such as clay, saw dust, absorbent pillows, sheets, or rolls
  - Diking
- Damming with soil straw bales or sand bags
- After the spill/release has been contained, or emergency response personnel have been contacted, notify the PM, RHSEM, and the EMO Authorized Representative.
- A spill or release of a hazardous substance at or above its Reportable Quantity will require reporting to the National Spill Response Center (see Table 10-1).

10.11 EMERGENCY EQUIPMENT AND FIRST AID REQUIREMENTS

A supply of emergency PPE and equipment will be maintained in sufficient quantities to ensure an adequate supply for emergency response. All emergency equipment will be fully stocked and readily accessible as needed. Refer to URS SMS Form 24-9 (Attachment B) for the Field First Aid Kit Supply List. The following emergency supplies will be available:

- Industrial first-aid kit (one 16-unit kit that complies with ANSI Z308A for every 25 persons or less)
- Bloodborne pathogen precaution kit with CPR mouth shield
- Instant cold packs
- Portable emergency eye wash and drenching station

- Fire extinguishers placed in the following locations:
  - In each piece of heavy equipment (10-B: C)
  - In each motor vehicle (10-B: C)
  - Adjacent to any flammable/combustible liquid or compressed gas storage area (20-A: 120-B: C)
  - Adjacent to any fueling area (20-A:120-B:C, maximum travel distance of 75 feet to an extinguisher)
  - Adjacent to any active generator or air compressor (20-A:120-B:C)
- Face shields
- PVC coveralls and/or poly-coated tyvek
- Chemical-resistant boot covers (latex)
- Chemical-resistant outer gloves
- Spill control/absorption supplies
- Soap or waterless hand cleaner and towels
- American Red Cross First Aid and CPR Instruction Manuals

11.1 REQUIRED DOCUMENTATION

The following documentation must be kept on site or readily accessible:

- OSHA Form 300, Log and Summary of Occupational Injuries and Illnesses
- Current HAZWOPER training certificates (including 8-hour refresher and site supervisor training)
- MSDSs for all hazardous chemicals brought on site by URS and its subcontractors
- OSHA-required medical surveillance examination clearance records
- Field logbook
- Copies of any Incident Reports
- Signed copies of the SSHP Compliance Agreement
- A completed Project Hazard Analysis Form
- Medical Data Sheets for all site personnel
- The Field First Aid Kit Supply List (URS SMS 24-9)
- Any other permits, training records, or documentation required by applicable URS SMS

11.2 TRAINING LOGS

Training logs will include initial site-specific safety training, daily safety briefings, weekly "toolbox" topic training, and visitor training. A record of the training will be documented on a training log, which will include the following information:

- The date
- Employee's name and social security number (attendance check)
- Time allocation in training session
- Training topic(s)
- Trainer(s) signature

11.3 FIELD LOG BOOK

The CHSO will maintain a logbook on site in accordance with standard URS procedures. Complete and detailed documentation of site activities will be very important. The following information will be recorded on a daily basis:

- Site conditions (e.g., weather)
- Activities being performed
- Personnel on site
- Site visitors

- Incidents, accident, and near misses
- Violations of health and safety procedures
- Other significant events

11.4 INCIDENT REPORTS

Upon receiving a report of an on-site incident, the CHSO will investigate the circumstances surrounding the incident. The incident reporting procedure will follow procedures outlined in URS SMS 49, Injury/Illness/Incident Reporting. Incidents will be reported using Form 49-1, and near misses will be reported using Form 49-2. All recordable work-related injuries and illnesses will be recorded on the OSHA 300 Form within 6 days. Subcontractors must also meet the requirements of maintaining an OSHA 300 Form.

The CHSO will also report all incidents, using USACE Eng Form 3394 (Attachment B); all injuries to URS employees and subcontractors that result in lost time; and all property/equipment damage greater than $2,000. The PM will verbally notify the EMO Authorized Representative of an incident within 24 hours, and a written report will be submitted on Form 3394 within 72 hours.

All project personnel, including visitors, must follow the requirements of this SSHP. In order to document individual agreement with this requirement, all personnel must complete this "Site Safety and Health Plan Compliance Agreement." These agreements will be kept on site and will become part of the permanent project record upon completion of site activities.

I, _____ (print name), have read the Site Safety and Health Plan (SSHP) for the Remedial Investigation, Building 6621, Fort Meade, Maryland; or I have been verbally advised of its contents. I understand and I agree to comply with all of its provisions. I understand that I could be prohibited from working on the project, and I may be subject to disciplinary actions for violating any of the health and safety requirements specified in the SSHP.

_____ _____

Signature Date

To be signed by site workers during the initial site-specific safety training to be provided by the SM/CHSO.

By their signature, the undersigned certify this Site Safety and Health Plan will be used for the protection of the health and safety of URS personnel, subcontractors, and visitors during the RI, Building 6621 area, Fort Meade, Maryland. The effective dates of this Plan are January, 2006 through December, 2006.

Bill Eaton

Bill Eaton.
Project Manager

January 9, 2006
Date

Patsy Glinsmann
Health, Safety and Environment
Representative

January 10, 2006
Date

ATTACHMENT A

Site Material Safety Data Sheets (MSDS)

Genium Publishing Corp.
One Genium Plaza
Schenectady, NY 12304-4690
(518) 377-8854

Chlordane **MSDS No. 877**

Date of Preparation: 10/93 Errata: 10/95

Section 1 - Chemical Product and Company Identification 42

Product/Chemical Name: Chlordane
Chemical Formula: $C_{10}H_6Cl_8$
CAS No.: 57-74-9 (pure), 12789-03-6 (technical)
Synonyms: Chlor Kil; Chlortox; dichlorochlordene; Dowchlor; NCI-C00099; Octachlor; octachlorodihydrodicyclopentadiene; 1,2,4,5,6,7,8,8-octachloro-2,3,3a,4,7,7a-hexahydro-4,7-methanoindene; octachloro-4,7-methanohydroindane; octachloro-4,7-methanotetrahydroindane; Topichlor 20; Velsicol 1068.
Derivation: By Diels-Alder addition of hexachlorocyclopentadiene to cyclopentadiene, followed by reaction with chlorine. Pure chlordane is a solid but in its commercial form it is mixed with a variety of solvents, namely deodorized kerosine. Typical concentrations are 2 to 80% chlordane.
General Use: Chlordane was used as an insecticide until its ban by the EPA in 1988. Its primary use was for termites, but was also effective on insects such as ants, cutworms, rose beetles, and grubs. A single application would provide termite protection for > 26 yr.
Vendors: Consult the latest *Chemical Week Buyers' Guide.* [73]

Section 2 - Composition / Information on Ingredients

Chlordane, 60 to 75% vol (technical grade, alpha and gamma isomers).
Impurities: Because chlordane is found in solution, there is a mixture (25 to 40%) of ~ 26 organochlorine compounds, including heptachlor (4 to 10%), nonachlor, Diels-Alder adduct of cyclopentadiene and pentachlorocyclopentadiene, hexachlorocyclopentadiene, and octachlorocyclopentene.

OSHA PEL
8-hr TWA: 0.5 mg/m^3(skin)

NIOSH REL
10-hr TWA: 0.5 mg/m^3(skin)

DFG (Germany) MAK
TWA: 0.5 mg/m^3(skin)
Category III: substances with systemic effects
Onset of Effect: > 2 hr
Half-life: > shift length (strongly cumulative)

ACGIH TLV
TWA: 0.5 mg/m^3(skin)

IDLH Level
Ca. 500 mg/m^3

Peak Exposure Limit: 5 mg/m^3, 30 min. average value, 1/shift

Section 3 - Hazards Identification

☆☆☆☆☆ Emergency Overview ☆☆☆☆☆

Chlordane is an organochlorine insecticide. It is a solid or a colorless to amber, viscous liquid with a pungent, chlorine odor. It was banned in 1988 by the EPA because of its toxicity and persistency and bioconcentration in the environment. Inhalation does not appear to be a significant problem at normal use levels, but high concentrations would produce effects. However, skin absorption and ingestion of even small amounts can adversely affect the central nervous system, liver, and kidneys. Numerous deaths have been associated with exposure to chlordane. The pure compound is noncombustible, but because it was produced as a solution, its flammability is dependent on the solvent used.

Wilson Risk Scale
R 1
I 3
S 2*
K 0
*Skin absorption

HMIS
H 2
F 1†
R 0

† Varies depending on the solvent(s) present. Doesn't burn when pure.
PPE‡
‡Sec. 8

Potential Health Effects

Primary Entry Routes: Skin absorption, ingestion, inhalation.
Target Organs: Skin, liver, kidneys, blood, central nervous system, respiratory system.
Acute Effects
Inhalation: Acute toxic exposures via inhalation would cause symptoms similar to those via ingestion.
Eye: Contact can be irritating.
Skin: Contact may produce irritation. This appears to have been more common prior to 1951 when a greater proportion of hexachlorocyclopentadiene was added. Chlordane can be absorbed through the skin in concentrations high enough to cause death. In one case, an accidental application caused death via respiratory failure within 40 minutes post exposure. (See ingestion symptoms)
Ingestion: Chlordane primarily affects the CNS by increasing excitability. Symptoms include confusion, agitation, tremor, incoordination, delirium, convulsions ranging from myoclonic jerking to violent seizures, and coma. Liver (enlargement) and kidney damage (no urine output due to degeneration of kidney tubules) is possible. Blood dyscrasias (imbalance in blood components) are common. Death is possible from respiratory or kidney failure.

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Carcinogenicity: Chlordane is listed by the following agencies in regard to carcinogenicity: EPA-B2 (Probable human carcinogen, sufficient animal and insufficient human evidence), IARC-2B (Possible human carcinogen, limited human evidence in absence of sufficient animal evidence), DFG MAK-B (Justifiably suspected as having carcinogenic potential), and NIOSH-X (Carcinogen defined without further categorization). In animal studies there is numerous evidence that chlordane is cancerous in mice, but these studies have not been reproduced in other animal species.

Medical Conditions Aggravated by Long-Term Exposure: Liver and kidney disorders.

Chronic Effects: Because chlordane is retained in fat cells, chronic toxicity is a problem. A survey of homeowners who had their homes treated for termites with chlordane reported symptoms such as sinusitis, bronchitis, migraine, asthma, neuritis and neuralgia (pain with or without nerve degeneration, respectively) and ovarian and uterine diseases. However, it cannot be determined which and how many of these effects were due solely to exposure to chlordane.

Section 4 - First Aid Measures

Inhalation: Remove exposed person to fresh air and support breathing as needed.

Eye Contact: *Do not* allow victim to rub or keep eyes tightly shut. *Gently* lift eyelids and flush immediately and continuously with flooding amounts of water for at least 15 min. *Do not* scrub! Consult a physician immediately.

Skin Contact: *Quickly* remove contaminated clothing. Rinse with flooding amounts of water for at least 15 min. Wash exposed area with soap and water. *Do not* scrub because this will increase absorption risk. For reddened or blistered skin, consult a physician.

Ingestion: Never give anything by mouth to an unconscious or convulsing person. Contact a poison control center. Unless the poison control center advises otherwise, have the *conscious and alert* person drink 1 to 2 glasses of water, then induce vomiting (most effective if done within 30 min. of ingestion).

After first aid, get appropriate in-plant, paramedic, or community medical support.

Note to Physicians: Chlordane's metabolites oxychlordane and heptachlor epoxide are indicators useful for biological monitoring. Dialysis, exchange transfusion, and hemoperfusion are ineffective. Oral administration of cholestyramine may enhance excretion.

Special Precautions/Procedures: Do not administer adrenergic amines which may further increase myocardial irritability and produce refractory ventricular arrhythmias. For seizures: Diazepam IV bolus - 5 to 10 mg, repeated every 15 min. PRN up to 30 mg. If seizures cannot be controlled or recur, administer phenytoin or phenobarbital.

Section 5 - Fire Fighting Measures

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Flash Point: 225°F (107.2 °C), in kerosine solvent. Flash point may be <100 °F (37.8 °C) depending on solvent. Pure chlordane is a noncombustible solid.

Flash Point Method: OC

Autoignition Temperature: 410°F (210°C) in kerosine solvent

LEL: 0.7% v/v (kerosine solvent)

UEL: 5% v/v (kerosine solvent)

Flammability Classification: Class IIIB Combustible liquid (in kerosine solvent).

Extinguishing Media: Use dry chemical, carbon dioxide, water spray, or alcohol-resistant foam.

Unusual Fire or Explosion Hazards: Container may explode in heat of fire. Vapors may travel to ignition source and flash back. Chlordane solutions pose a vapor explosion hazard indoors, outdoors, and in sewers.

Hazardous Combustion Products: Include chlorine, hydrogen chloride, phosgene, and carbon oxide gases.

Fire-Fighting Instructions: If possible without risk, move container from fire area. Apply cooling water to container sides until well after fire is out. Stay away from ends of tanks. Withdraw immediately if you hear a rising sound from venting safety device or notice any tank discoloration due to fire. Do not release runoff from fire control methods to sewers or waterways.

Fire-Fighting Equipment: Because fire may produce toxic thermal decomposition products, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in pressure-demand or positive-pressure mode. Structural firefighters' protective clothing is not effective for fires involving chlordane.

Section 6 - Accidental Release Measures

Spill /Leak Procedures: Notify safety personnel, isolate and ventilate area, deny entry, and stay upwind. Shut off all ignition sources. Cleanup personnel should protect against exposure.

Small Spills: Take up with earth, sand, vermiculite, or other absorbent, noncombustible material.

Large Spills

Containment: For large spills, dike far ahead of liquid spill for later disposal. Do not release into sewers or waterways.

Cleanup: Mop any residue with a mild alkali solution (will release the chlorine).

Regulatory Requirements: Follow applicable OSHA regulations (29 CFR 1910.120).

Section 7 - Handling and Storage

Handling Precautions: Use non-sparking tools to open containers.

Storage Requirements: Store in a cool, dry, well-ventilated area away from heat, ignition sources, and incompatibles (Sec. 10). Containers should be aluminum, aluminum clad, or high-bake phenolic enamel-lined metal.

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Section 8 - Exposure Controls / Personal Protection

Engineering Controls: To prevent static sparks, electrically bond and ground all equipment used with and around chlordane.
Ventilation: Provide general or local exhaust ventilation systems to maintain airborne concentrations below OSHA PELs (Sec. 2). Local exhaust ventilation is preferred because it prevents contaminant dispersion into the work area by controlling it at its source.(103)
Administrative Controls: Consider preplacement and periodic medical exams of exposed workers with emphasis on the skin, liver, kidneys, blood, CNS and respiratory system.
Respiratory Protection: Seek professional advice prior to respirator selection and use. Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, wear a MSHA/NIOSH-approved respirator. For any detectable levels, use a SCBA or supplied-air respirator (with auxiliary SCBA) with a full facepiece and operated in pressure-demand or other positive pressure mode. For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), wear an SCBA. *Warning! Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.* If respirators are used, OSHA requires a written respiratory protection program that includes at least: medical certification, training, fit-testing, periodic environmental monitoring, maintenance, inspection, cleaning, and convenient, sanitary storage areas.
Protective Clothing/Equipment: Wear chemically protective gloves, boots, aprons, and gauntlets to prevent prolonged or repeated skin contact. Teflon has a breakthrough time of > 4 hr and is a suitable material for PPE. Wear protective eyeglasses or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133). Because contact lens use in industry is controversial, establish your own policy.
Safety Stations: Make available in the work area emergency eyewash stations, safety/quick-drench showers, and washing facilities.
Contaminated Equipment: Separate contaminated work clothes from street clothes. Launder before reuse. Remove this material from your shoes and clean personal protective equipment.
Comments: Never eat, drink, or smoke in work areas. Practice good personal hygiene after using this material, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

Section 9 - Physical and Chemical Properties

Physical State: Solid (pure), liquid (technical)
Appearance and Odor: Colorless to amber, viscous liquid with a pungent, chlorine odor.
Odor Threshold: 5×10^{-4} ppm
Vapor Pressure: 0.00001 mm Hg at 77 °F (25 °C)
Formula Weight: 409.8
Specific Gravity (H_2O=1, at 4 °C): 1.56 at 25 °C (77 °F)
Water Solubility : 9 µg/L at 77 °F (25 °C)
Octanol/Water Partition Coefficient: log Kow = 2.78
Other Solubilities: Soluble in aliphatic and aromatic hydrocarbons including deodorized kerosine. Decomposes in alkalis.
Boiling Point: 347 °F (175 °C) at 2 mm Hg
Melting Point: 203 to 204.8 °F (95 to 96 °C), *pure* solid
Viscosity: 69 P at 77 °F (25 °C)
Refraction Index: 1.56 to 1.57 at 77 °F (25 °C)
Surface Tension: 25 dyne/cm at 68 °F (20 °C)

Section 10 - Stability and Reactivity

Stability: Chlordane is stable at room temperature in closed containers under normal storage and handling conditions.
Polymerization: Hazardous polymerization does not occur.
Chemical Incompatibilities: Include oxidizers and alkalis. Corrosive to iron and zinc. Attacks some forms of plastics, rubber, and coatings.
Conditions to Avoid: Exposure to heat, ignition sources, and incompatibles.
Hazardous Decomposition Products: Thermal oxidative decomposition of chlordane can produce toxic chlorine, phosgene, hydrogen chloride, and carbon oxide gases.

Section 11- Toxicological Information

Toxicity Data:*

Acute Inhalation Effects:
Cat, inhalation, LC_{50}: 100 mg/m^3/4 hr caused somnolence, excitement and convulsions or effect on seizure threshold.
Carcinogenicity: Mouse, oral: 2020 mg/kg given for 80 continuous weeks caused liver tumors.
Mutagenicity: Human, lymphocyte cell: 10 µmol/L caused mutation.
Teratogenicity: Mouse, oral: 152 mg/kg given for 1 to 19 days of pregnancy caused developmental abnormalities of the immune and reticuloendothelial systems.
Acute Oral Effects:
Man, oral, TD_{Lo}: 3071 µg/kg produced coma, difficulty breathing, and nausea or vomiting.
Human, oral, LD_{Lo}: 29 mg/kg caused fatty liver degeneration.
Human, skin, LD_{Lo}: 428 mg/kg caused tremor, ataxia, and convulsions or effect on seizure threshold.
Rat, oral, LD_{50}: 200 mg/kg

* See NIOSH, *RTECS* (PB9800000), for additional toxicity data.

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Section 12 - Ecological Information

Ecotoxicity: Goldfish, TLm = 0.5 ppm/96 hr; bluegill, LC_{50} = 57 to 74.8 µg/L/96 hr; brown trout, LC_{50} = 11.1 µg/L/96 hr; mallard duck, LD_{50} = 858 ppm; pheasant, LD_{50} = 430 ppm.
Bioconcentration: Pinfish (*Lagodon rhomboides*), 96 hr BCF = 6227; frogs (*Xenopus laevis*), 96 hr BCF = 108
Environmental Degradation: Chlordane is not very mobile in soil and is not likely to leach. The degradation rate is estimated at 4.05 to 28.33%/yr with a mean half-life of 3.3 yr. It can volatilize from the surface (especially if soil is moist). In water, chlordane is not expected to hydrolyze oxidize, or undergo direct photolysis. It volatilizes with an estimated half-life of 7.3 to 7.9 hr from a river 1 m deep, glowing 1 m/sec, with a wind velocity of 3 m/sec at 73.4 °F (23 °C). In air, chlordane will react in the vapor phase with photochemically produced hydroxyl radicals with an estimated half-life of 6.2 hr.

Section 13 - Disposal Considerations

Disposal: Chlordane is a good candidate for liquid injection incineration or rotary kiln incineration. Although chlordane is decomposed by alkalis, the basic objection to this treatment is time. It could take several days to weeks to ensure complete hydrolysis. If spilled in water at > 10 ppm, apply activated carbon at 10 X spilled amount. Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.
Container Cleaning and Disposal: Triple rinse containers and dispose of rinse water as you would other chlordane waste. If possible, return to supplier for reuse or if this is not in accordance with 49 CFR 173.28, puncture container and either ship to scrap metal facility for recycling or send to landfill.

Section 14 - Transport Information

DOT Transportation Data (49 CFR 172.101):

Shipping Name: Organochlorine pesticides liquid, flammable, toxic, n.o.s. flash point less than 23 °C*
Shipping Symbols: –
Hazard Class: 3
ID No.: UN2762
Packing Group: II
Label: Flammable liquid, Poison
Special Provisions (172.102): –

Packaging Authorizations
a) Exceptions: None
b) Non-bulk Packaging: 173.202
c) Bulk Packaging: 173.243

Quantity Limitations
a) Passenger, Aircraft, or Railcar: 1 L
b) Cargo Aircraft Only: 60 L

Vessel Stowage Requirements
a) Vessel Stowage: B
b) Other: –

* Depending on the flash points of the solvent involved, if greater than 73 °F (23 °C), the UN No. will be 2995.

Section 15 - Regulatory Information

EPA Regulations:
Listed as a RCRA Hazardous Waste Number (40 CFR 261.33): U036
RCRA Hazardous Waste Classification (40 CFR 261.33): Not classified
Listed as a CERCLA Hazardous Substance (40 CFR 302.4) per CWA, Sec. 311 (b)(4)
CERCLA Reportable Quantity (RQ), 1 lb (0.454 kg)
SARA 311/312 Codes: 1, 2
Listed as a SARA Toxic Chemical (40 CFR 372.65)
Listed as a SARA EHS (Extremely Hazardous Substance) (40 CFR 355): Threshold Planning Quantity (TPQ): 1,000 lb
OSHA Regulations:
Listed as a Air Contaminant (29 CFR 1910.1000, Table Z-1, Z-1-A)

Section 16 - Other Information

References: 73, 103, 124, 126, 127, 132, 133, 136, 148, 153, 168, 183, 186

Prepared By ..... M Gannon, BA
Industrial Hygiene Review ..... DJ Wilson, CIH
Medical Review ..... J Brent, MD, PhD

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Section 1 - Chemical Product and Company Identification

Product/Chemical Name: Malathion
Chemical Formula: $(CH_3O)_2P(S)SCH(COOC_2H_5)CH_2COOC_2H_5$
CAS No.: 121-75-5
Synonyms: carbophos; Cythion; O,O-dimethyl dithiophosphate of diethyl mercaptosuccinate; O,O-dimethyl-S-(1,2-dicarbethoxyethyl) phosphorodithioate; Maldison; mercaptothion
Derivation: Obtained from diethyl maleate and dimethyldithiophosphoric acid. **General Use:** As an insecticide for the control of mosquitoes, flies, spiders, animal ectoparasites, and human head and body lice. **Vendors:** Consult the latest *Chemical Week Buyers' Guide.* (73)

Section 2 - Composition / Information on Ingredients

Malathion, 99.6 % vol: technical grade; 25% and 50%: wettable powders
Trace Impurities: phosphorothioate and phosphorodithioate; malaoxon (crude grade impurity)

OSHA PELs, *Skin*
8-hr TWA :15 mg/m^3, total dust

Vacated 1989 Final Rule Limit:
8-hr TWA: 10 mg/m^3, total dust
5 mg/m^3, respirable fraction

NIOSH REL, *Skin*
10-hr TWA: 10 mg/m^3

IDLH Level
5000 mg/m^3

DFG (Germany) MAK
Ceiling: 15 mg/m^3, total dust

ACGIH TLVs, *Skin*
TWA: 10 mg/m^3*

* Biological Exposure Index for organophosphorus cholinesterase inhibitors: 70% of individual's baseline.

Section 3 - Hazards Identification

☆☆☆☆☆ Emergency Overview ☆☆☆☆☆

Malathion is a colorless (when pure) to light-amber liquid with a skunk-like or garlic odor. It is an anticholinesterase agent and severe intoxication causes profound pulmonary secretions and respiratory distress. Take the necessary precautions to prevent any exposure to malathion. It is absorbed through the skin and may produce systemic effects.

Wilson Risk Scale
R 1
I 2
S 1*
K 1
* Skin absorption

HMIS
H 2
F 1
R 1

PPE†
†Sec. 8

Potential Health Effects

Primary Entry Routes: Inhalation, ingestion, skin absorption.
Target Organs: Respiratory system, liver, blood cholinesterase, gastrointestinal tract, and central nervous and cardiovascular systems.
Acute Effects
Severe Intoxication by all Routes: Weakness, general twitching and paralysis, dizziness, confusion, staggering, slurred speech, sweating, irregular or slow heartbeat, convulsions, breathing may stop, and coma. **Inhalation:** Tightness of the chest, wheezing, increased pulmonary secretions, bluish discoloration of skin, small pupils, aching in and behind eyes, blurred vision, tearing, runny nose, headache, and watering of the mouth. **Eye:** Irritation.
Skin: Skin absorption causes sweating and twitching in area of absorption usually within 15 min to 4 hr. Weak skin sensitization and dermatitis may occur at high exposures.
Ingestion: Loss of appetite, nausea, vomiting, abdominal cramps, diarrhea within 2 hr.
Carcinogenicity: IARC, NTP, and OSHA do not list malathion as a carcinogen. IARC designates malathion as Group 3 (not classifiable as to carcinogenicity to humans).
Medical Conditions Aggravated by Long-Term Exposure: Central nervous system disorders.
Chronic Effects: Repeated exposure to malathion may make a person more susceptible to the effects of organophosphates.
Comments: Malathion is an anticholinesterase agent which causes the inactivation of the enzyme cholinesterase resulting in the accumulation of acetylcholine at synapses in the neuromuscular system and secretory glands. It is less toxic to humans than most anticholinesterase agents because malathion and its metabolite, malaoxon, are metabolized in the liver to an inactive form. The acute lethal dose is estimated to be somewhat below 1.0 g/kg.

Section 4 - First Aid Measures

Inhalation: Remove exposed person to fresh air and support breathing as needed.
Eye Contact: *Do not* allow victim to rub or keep eyes tightly shut. Gently lift eyelids and flush immediately and continuously with flooding amounts of water until transported to an emergency medical facility. Consult a physician or ophthalmologist immediately.

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Skin Contact: *Quickly* remove contaminated clothing. Rinse with flooding amounts of water for at least 15 min. Thoroughly wash exposed area with soap and water. Do repeat soap washings. For reddened or blistered skin, consult a physician.

Ingestion: Never give anything by mouth to an unconscious or convulsing person. Contact a poison control center. Unless the poison control center advises otherwise, *do not* induce vomiting because of possible early onset of respiratory depression and seizures. Consider gastric lavage after control of any seizures.

After first aid, get appropriate in-plant, paramedic, or community medical support.

Note to Physicians: Give 5 mg of atropine intravenously. Atropine may induce ventricular fibrillation in the presence of cyanosis. Repeat the dose of atropine at 5- to 10-minute intervals until signs of atropinization appear (dry, flushed skin, tachycardia as high as 140 beats/min, and pupillary dilatation). Repeat the dose of atropine if muscarinic symptoms appear. Maintain a mild degree of atropinization for at least 48 hr. Pralidoxime (2-PAM, Protopam) chloride is a cholinesterase reactivator that complements the action of atropine. For moderate-to-severe cases, give adults 1 to 2 g intravenously at a rate not in excess of 500 mg/min. A second dose of 1 g is indicated if muscle weakness has not been relieved, or if it recurs within 20 min. Pralidoxime chloride is ineffective after aging has occurred. Morphine, aminophyline, and phenothiazines are contraindicated. Depression in red blood cell cholinesterase in excess of 50% activity is generally associated with severe symptoms. Correlation between cholinesterase levels and clinical effects in milder poisonings may be poor. Individuals homozygous for the CHE gene display a defective serum butyrylcholinesterase and are particularly vulnerable to poisoning by organophosphorus insecticides.

Special Precautions/Procedures: Emergency personnel should protect against exposure when rescuing victims.

Section 5 - Fire-Fighting Measures

Flash Point: >325 °F (>163 °C)
Flash Point Method: OC
Autoignition Temperature: None reported.
LEL: None reported.
UEL: None reported.

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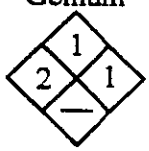

Flammability Classification: Class IIIB Combustible Liquid, but may be difficult to ignite.
Extinguishing Media: Small fires: use dry chemical or carbon dioxide. Large fires: use water spray or foam.
Unusual Fire or Explosion Hazards: Containers may explode in the heat of fire.
Hazardous Combustion Products: Sulfur dioxide, phosphoric acid, phosphorus oxides, and carbon monoxide.
Fire-Fighting Instructions: If feasible and without undue risk, move containers from fire hazard area. Otherwise, cool fire-exposed containers with water spray until well after fire is extinguished. Do not release runoff from fire control methods to sewers or waterways.
Fire-Fighting Equipment: Because fire may produce toxic thermal decomposition products, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in pressure-demand or positive-pressure mode. Structural firefighters' protective clothing is *not* effective. Wear chemically protective clothing specifically recommended by the manufacturer. Decontaminate equipment and clothing with a chlorine bleach solution.

Section 6 - Accidental Release Measures

Spill /Leak Procedures: Notify safety personnel of large spills, evacuate all unnecessary personnel, provide adequate ventilation, and remove all heat and ignition sources. Cleanup personnel should protect against exposure. Fully-encapsulating, vapor-protective clothing (polycarbonate, butyl rubber, PVC, nitrile, Neoprene) is recommended.
Small Spills: Take up with sand or noncombustible absorbent material and place into containers for later disposal. For dry spills, scoop up with a clean shovel and place into a clean, dry container for disposal.
Large Spills
Containment: For large spills, dike far ahead of liquid spill for later disposal. Do not release into sewers or waterways.
Cleanup: Decontaminate equipment and surfaces with an alkaline solution (5% sodium hydroxide).
Regulatory Requirements: Follow applicable OSHA regulations (29 CFR 1910.120).

Section 7 - Handling and Storage

Handling Precautions: Avoid any contact with skin or vapor inhalation. Use only with adequate personal protective equipment and proper ventilation.
Storage Requirements: Store in tightly closed and properly labeled containers in a cool, well-ventilated area. Outdoor or detached storage is preferred. *Do not* store in iron, steel, tin plate, lead, or copper containers.

Section 8 - Exposure Controls / Personal Protection

Engineering Controls: To prevent static sparks, electrically ground and bond all containers and equipment used in shipping, receiving, or transferring operations in production and storage areas.
Ventilation: Provide general or local exhaust ventilation systems to maintain airborne concentrations below OSHA PELs (Sec. 2). Local exhaust ventilation is preferred because it prevents contaminant dispersion into the work area by controlling it at its source.[103]

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Administrative Controls: Provide preplacement and periodic medical exam with emphasis on the respiratory system, liver, and blood cholinesterase levels. Biological Exposure Index (BEI): cholinesterase activity in red blood cells (timing is discretionary) is 70% of individual's baseline. Background levels are included in the BEI value. Consider precluding from exposure those individuals whose red blood cell cholinesterase falls to or below 40% of the preexposure baseline until the activity returns to within 70% of the preexposure baseline. **Respiratory Protection:** Seek professional advice prior to respirator selection and use. Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, wear a MSHA/NIOSH-approved respirator. Select respirator based on its suitability to provide adequate worker protection for given working conditions, level of airborne contamination, and presence of sufficient oxygen. For concentrations ≤ 100 mg/m^3, wear any supplied-air respirator, any SCBA, or any chemical cartridge respirator with organic vapor cartridge(s) in combination with a dust, mist, and fume filter. For concentrations ≤ 250 mg/m^3, wear any supplied-air respirator operated in a continuous-flow mode; or any powered, air-purifying respirator with organic vapor cartridge(s) in combination with a dust, mist, and fume filter. For concentrations ≤ 500 mg/m^3, wear any self-contained breathing apparatus with a full facepiece or any supplied-air respirator with a full facepiece or any chemical cartridge respirator with a full facepiece and organic vapor cartridge(s) in combination with a high-efficiency particulate filter; or any air-purifying, full-facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having a high-efficiency particulate filter; or any powered, air-purifying respirator with a tight-fitting facepiece and organic vapor cartridge(s) in combination with a high-efficiency particulate filter; or any supplied-air respirator that has a tight-fitting facepiece and is operated in a continuous-flow mode. For concentrations ≤ 5000 mg/m^3, wear any supplied-air respirator operated in a pressure-demand or other positive-pressure mode. For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), wear an SCBA. *Warning! Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.* If respirators are used, OSHA requires a written respiratory protection program that includes at least: medical certification, training, fit-testing, periodic environmental monitoring, maintenance, inspection, cleaning, and convenient, sanitary storage areas. **Protective Clothing/Equipment:** Wear chemically protective gloves, boots, aprons, and gauntlets to prevent prolonged or repeated skin contact. Whole-body coveralls and chemically protective footwear are recommended. Wear protective eyeglasses or chemical safety, splash-proof goggles and face shields (8 inch minimum) per OSHA eye- and face-protection regulations (29 CFR 1910.133). Contact lenses are not eye protective devices. Appropriate eye protection must be worn instead of, or in conjunction with contact lenses. **Safety Stations:** Make emergency eyewash stations, safety/quick-drench showers, and washing facilities available in work area. **Contaminated Equipment:** Separate contaminated work clothes from street clothes. Launder before reuse. Remove this material from your shoes and clean personal protective equipment. **Comments:** Never eat, drink, or smoke in work areas. Practice good personal hygiene after using this material, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

Section 9 - Physical and Chemical Properties

Physical State: Liquid
Appearance and Odor: Colorless (when pure) to light amber with a skunk-like or garlic odor
Odor Threshold: 13.5 mg/m^3
Vapor Pressure: 1.25 x 10^{-4} mm Hg at 68 °F (20 °C); 4 x 10^{-5} at 86° F (30 °C)
Formula Weight: 330.36
Density (H_2O=1, at 4 °C): 1.23 at 77 °F (25 °C)
Water Solubility: Slightly soluble; 145 ppm at 20 °C
Other Solubilities: Alcohols, esters, ketones, ethers, vegetable oils, benzene, hexane, aromatic and alkylated aromatic hydrocarbons; limited solubility in paraffin hydrocarbons
Boiling Point: 140 °F (60 °C); decomposes
Freezing/Melting Point: 37.2 °F (2.9 °C)
Refraction Index: 1.4960 at 20 °C/D
Surface Tension: 37.1 dynes/cm at 75 °F (24 °C)
Octanol/Water Partition Coefficient: Log Kow=2.36

Section 10 - Stability and Reactivity

Stability: Malathion is stable in an aqueous solution buffered to pH 5.26. **Polymerization:** Hazardous polymerization cannot occur. **Chemical Incompatibilities:** Corrodes iron, steel, tin plate, lead and copper; will attack some forms of plastics, rubber, and coatings; and is also incompatible with strong oxidizers, magnesium, and alkaline pesticides. **Conditions to Avoid:** Avoid heat and ignition sources and incompatibles. **Hazardous Decomposition Products:** Thermal oxidative decomposition of malathion can produce sulfur dioxide, phosphoric acid, carbon monoxide, and phosphorus oxides. Malathion may isomerise at high temperatures and form the more toxic isomalathion. It starts to decompose at 140 °F (60 °C) and at > 212 °F (> 100 °C) it decomposes explosively.

Section 11- Toxicological Information

Toxicity Data:*

Acute Inhalation Effects:
Rat, inhalation, LC_{50}: 84600 µg/m^3/4 hr

Acute Effects:
Woman, oral, LD_{Lo}: 246 mg/kg caused blood pressure lowering not characteristic in autonomic section, chronic pulmonary edema, and dermatitis.
Man, oral, LD_{Lo}: 471 mg/kg caused coma, blood pressure lowering not characteristic in autonomic section, and shortness of breath.

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Acute Effects continued:
Rat, oral, LD_{50}: 290 mg/kg
Rat, skin, LD_{50}: > 4444 mg/kg
Reproductive Effects:
Rat, oral, 283 mg/kg administered to the female during 9 days of pregnancy caused specific developmental abnormalities of the urogenital system.
* See NIOSH, *RTECS* (WM8400000), for additional toxicity data.

Genetic Effects:
Human, lymphocyte: 70 mg/L caused DNA inhibition.
Human, fibroblast: 5 mg/L caused sister chromatid exchange.

Section 12 - Ecological Information

Ecotoxicity: Bluegill, fresh water, TLm, 96 hr: 0.09 ppm; Marine crustaceae, 96 hr: 0.033-0.083 ppm. Waterfowl, LD_{50}: 1485 mg/kg. **Environmental Fate:** A Koc of 280 has been estimated on the reported solubility of 145 ppm at 20 °C, vapor pressure of 4×10^{-5} mm Hg at 30 °C, and a Henry's law constant of 1.2×10^{-7} atm m^3/mol. **Environmental Degradation:** If released to water, malathion is subject to biodegradation and photodegradation at the surface and it may moderately absorb to sediment, but will not be expected to bioconcentrate in aquatic organisms. Volatilization from water should not be an important fate process. Hydrolysis in water may be an important fate process based on reported half-life range of 0.2 weeks at pH 8.0 to 21 weeks at pH 6.0. Products of hydrolysis include malaoxon; malathion, alpha and beta monoacid; O,O-dimethyl phosphorodithionic acid; diethyl fumarate; diethyl thiomalate; and O,O-dimethyl phosphorothionic acid. Iron catalyzes hydrolysis and humic substances accelerate photolysis. Persistence of malathion in water from 4 rivers ranged from 52% still present after 11 days to 21% after 14 days. Biodegradation may be an important fate process, especially in soils at pH <7 where the rate of hydrolysis may be slow relative to the rate of biodegradation. The major metabolite in soil is malathion beta monoacid. **Soil Absorption/Mobility:** Malathion will moderately bind to the soil and it will be subject to significant biodegradation and hydrolysis. Leaching is a viable route of transport in soil. Absorption is the best in high organic content, enhanced by the presence of metallic clays. The half-life in soil: 4 to average 6 days. **Analytical Method:** EPA Method 8141 is a gas chromatographic method used to determine malathion in ground water, soil, and non-water miscible waste.

Section 13 - Disposal Considerations

Disposal: Incinerate with flammable solvent in a furnace equipped with an afterburner and scrubber (permit-approved facility). Wastewater treatment technology: biological treatment and reverse osmosis. Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations. **Container Cleaning and Disposal:** Triple rinse containers and dispose of waste water as you would dispose of malathion unless it can be used for diluent.

Section 14 - Transport Information

DOT Transportation Data (49 CFR 172.101):

Shipping Name: Organophosphorus pesticides, liquid, toxic, n.o.s.
Shipping Symbols:
Hazard Class: 6.1
ID No.: UN3018
Packing Group: I
Label: POISON
Special Provisions (172.102): N76, T42

Packaging Authorizations
a) Exceptions: None
b) Non-bulk Packaging: 173.201
c) Bulk Packaging: 173.243

Quantity Limitations
a) Passenger, Aircraft, or Railcar: 1 L
b) Cargo Aircraft Only: 30 L

Vessel Stowage Requirements
a) Vessel Stowage: B
b) Other: 40

Section 15 - Regulatory Information

EPA Regulations:
RCRA Hazardous Waste (40 CFR 261.33): Not listed*
Listed as a CERCLA Hazardous Substance (40 CFR 302.4) per CWA, Sec. 311 (b)(4)
CERCLA Reportable Quantity (RQ), 100 lb (45.4 kg)
SARA Toxic Chemical (40 CFR 372.65): Not listed
SARA EHS (Extremely Hazardous Substance) (40 CFR 355): Not listed
OSHA Regulations:
Listed as an Air Contaminant (29 CFR 1910.1000, Table Z-1, Z-1-A)
* Malathion may be classified as a RCRA Hazardous Waste, Characteristic of Corrosivity, because it corrodes steel. See 40 CFR 261.22 for specific criteria.

Section 16 - Other Information

References: 26, 73, 100, 101, 103, 124, 132, 136, 139, 140, 148, 153, 164, 167, 168, 174, 175, 176, 180, 183, 189, 190
Prepared By MJ Wurth, BS **Industrial Hygiene Review** RE Langford, PhD, CIH **Medical Review** J Brent, MD, PhD
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Material Safety Data Sheets Collection

DDT (Dichlorodiphenyltrichloroethane)
MSDS No. 155
Date of Preparation: 10/93

Section 1 - Chemical Product and Company Identification 42

Product/Chemical Name: .... DDT (Dichlorodiphenyltrichloroethane)
Chemical Formula: ..... $(ClC_6H_4)_2CHCCl_3$
CAS No.:..... 50-29-3
Synonyms: Agritan; 2,2-bis(*p*-chlorophenyl)-1,1,1-trichloroethane; chlorophenothan; Citox; dichlorodiphenyltrichloroethane; Dicophane; diphenyltrichloroethane; Genitox; Kopsol; NCI-C00464; Neocid; Pentech; trichlorobis (4-chlorophenyl) ethane; 1,1'-(2,2,2-trichloroethylidene)bis(4-chlorobenzene), Zerdane.
Derivation: Prepared by condensing chloral or chloral hydrate with chlorobenzene in presence of sulfuric acid.
General Use: One of the most widely used contact insecticides from 1945 until its ban in 1972. Although banned in the U.S. (except for such uses as emergency health situations and for controlling body lice), it is still widely used in the tropics for control of vector-carrying diseases such as malaria, yellow fever, dengue, filariasis, louse-borne typhus, and louse-borne relapsing fever.

Section 2 - Composition / Information on Ingredients

DDT: *p'p'*DDT 70% wt + *o'p'*DDT 30% wt (technical grade)
Trace Impurities: DDD, DDE

OSHA PELs
8-hr TWA: 1 mg/m^3 (skin)

ACGIH TLVs
TWA: 1 mg/m^3

NIOSH REL
10-hr TWA: 0.5 mg/m^3
Ca*: (Limit of quantitation: 0.1 mg/m^3)

IDLH Level
Ca*

DFG (Germany) MAK (skin)
TWA: 1 mg/m^3 (total dust)
Category III: Substances with systemic effects
Onset of effect: > 2 hr.
Peak Exposure Limit: 10 mg/m^3, 30 min. average value, 1/shift

* Ca = Carcinogen

Section 3 - Hazards Identification

☆☆☆☆☆ Emergency Overview ☆☆☆☆☆

DDT is a white to gray, crystalline solid. Although it has been banned in the U.S. because of its persistence in the environment and potential for bioaccumulation, DDT has not produced toxicity in workers who either manufactured or used it (even over many years). However, this lack of toxicity is based on inhalation and skin absorption. If DDT is ingested, especially in large amounts, central nervous system effects will occur with possible liver damage. DDT is considered a confirmed animal carcinogen and a suspected human carcinogen.

Wilson Risk Scale
R 1
I 3
S 1*
K 2
*Skin absorption

HMIS
H 2†
F 2
R 0
†chronic effects
PPE‡
‡Sec. 8

Potential Health Effects

Primary Entry Routes: Inhalation, ingestion, skin contact.
Target Organs: Central nervous system, liver, skin, peripheral nervous system.
Acute Effects
Inhalation: Inhalation does not appear to cause toxicity beyond that of minor mechanical irritation.
Eye: Exposure to 423 mg/m^3/1 hr/day for 6 days caused eye irritation.
Skin: Skin absorption may occur from some DDT solutions, but degree of absorption will depend on the solvent involved. Aqueous solutions and the powder or crystals are not easily absorbed.
Ingestion: DDT can cause a variety of central nervous system effects if ingested. Large doses generally result in vomiting, while smaller doses cause symptoms within 2 to 3 hr post-ingestion. Symptoms include tingling of the lips, tongue, and face; malaise; headache; sore throat; fatigue; tremors of the head, neck, and eyelids; apprehension; ataxia; and confusion. Convulsions and paralysis of the hands is possible in severe exposures (if vomiting does not occur). Vital signs are usually normal, but in severe poisonings, the pulse may be irregular and abnormally slow. Based on animal studies, it is expected that ventricular fibrillation and sudden death can occur at any time during acute poisoning. Recovery from acute poisoning generally occurs within 24 hr except in the most serious cases.
Carcinogenicity: DDT is considered a suspected human carcinogen by several governmental agencies. IARC-2B (possibly carcinogenic to humans, limited evidence in humans in the absence of sufficient evidence in experimental animals), NTP-2 (reasonably anticipated to be a carcinogen: limited human evidence or sufficient animal evidence), EPA-B2 (sufficient animal evidence; inadequate human evidence), and NIOSH-X (carcinogen defined without further categorization)
Medical Conditions Aggravated by Long-Term Exposure: Possibly, disorders of the central nervous system and liver.

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Chronic Effects: There are conflicting reports on whether or not DDT produces chronic effects in humans. Although it is well established that chronic exposure in experimental animals produces effects including liver damage, CNS degeneration, dermatitis, weakness, convulsions, coma, and death, these effects are not confirmed in humans. Liver cancer is confirmed in animals, but has not been documented in humans. These conflicting reports appear due to the lack of documented chronic toxicity in workers and data showing that DDT and its metabolites are retained in the body fat for long time periods, thus providing a basis for the *possibility* of chronic toxicity.

Other: Solvents such as kerosine are added to DDT as a vehicle and, depending on the type involved, may be more toxic than DDT itself.

Section 4 - First Aid Measures

Inhalation: Remove exposed person to fresh air and support breathing as needed.

Eye Contact: *Do not* allow victim to rub or keep eyes tightly shut. Gently lift eyelids and flush immediately and continuously with flooding amounts of water until transported to an emergency medical facility. Consult a physician immediately.

Skin Contact: *Quickly* remove contaminated clothing. Rinse away any loose material and wash exposed area with soap and water. For reddened or blistered skin, consult a physician. Carefully dispose of contaminated clothing because it may pose a fire hazard.

Ingestion: Never give anything by mouth to an unconscious or convulsing person. Contact a poison control center. Unless the poison control center advises otherwise, have the *conscious and alert* person drink 1 to 2 glasses of water to dilute. *Do not* induce vomiting. Gastric lavage should be performed promptly.

After first aid, get appropriate in-plant, paramedic, or community medical support.

Notes to Physicians: Effects may be delayed; keep under observation.

Special Precautions/Procedures: Amobarbital or pentobarbital is recommended for the relief of central neurological manifestations; tribromoethanol and paraldehyde are recommended for allaying prolonged convulsions.

Section 5 - Fire-Fighting Measures

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Flash Point: DDT itself is noncombustible but is dissolved in a variety of solvents. The average quoted Flash Point is 162 °F (72.2 °C) although the specific vehicle is not identified.

Flash Point Method: CC

Autoignition Temperature: None reported

LEL: None reported

UEL: None reported

Flammability Classification: Class IIIA Combustible Liquid (varies depending on vehicle)

Extinguishing Media: For small fires, use dry chemical, water spray, or regular foam. For large fires, use water spray, fog, or regular foam.

Unusual Fire or Explosion Hazards: Container may explode in heat of fire.

Hazardous Combustion Products: Chloride fumes and carbon oxide gases.

Fire-Fighting Instructions: Do not release runoff from fire control methods to sewers or waterways. Fight fire from maximum distance. Stay away from ends of tanks.

Fire-Fighting Equipment: Because fire may produce toxic thermal decomposition products, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in pressure-demand or positive-pressure mode. Structural fire fighters' protective clothing is *not* effective.

Section 6 - Accidental Release Measures

Spill /Leak Procedures: Notify safety personnel, isolate area, deny entry, and stay upwind. Shut off all ignition sources. Cleanup personnel should protect against contamination.

Small Spills: For dry spills, carefully scoop up material or vacuum (with an approved filter). Damp mop any residue. For small solution spills, take up with earth, sand, vermiculite, or other absorbent material and place in suitable containers for disposal.

Large Spills

Containment: Dike far ahead of liquid spill for later reclamation or disposal. Do not release into sewers or waterways.

Regulatory Requirements: Follow applicable OSHA regulations (29 CFR 1910.120).

Section 7 - Handling and Storage

Handling Precautions: Use non-sparking tools to open containers. Keep dry chemical extinguishers on hand in case of fire.

Storage Requirements: Prevent physical damage to containers. Store in a cool, dry, well-ventilated area away from heat, ignition sources, and incompatibles (Sec. 10). *Do not* store in aluminum or iron containers.

Section 8 - Exposure Controls / Personal Protection

Engineering Controls: To prevent static sparks, electrically ground and bond all equipment used with and around DDT.

Ventilation: Provide general or local exhaust ventilation systems to maintain airborne concentrations below OSHA PEL (Sec. 2). Local exhaust ventilation is preferred because it prevents contaminant dispersion into the work area by controlling it at its source.[103]

Administrative Controls: Consider preplacement and periodic medical exams of exposed workers with emphasis on the liver and central nervous system.

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Respiratory Protection: Seek professional advice prior to respirator selection and use. Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, wear a MSHA/NIOSH-approved respirator. For any detectable concentration, use a SCBA with a full facepiece and operated in pressure demand or other positive-pressure mode, or any supplied-air respirator with a full facepiece and operated in pressure demand or other positive-pressure mode with an auxiliary SCBA. For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), wear an SCBA. *Warning! Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.* If respirators are used, OSHA requires a written respiratory protection program that includes at least: medical certification, training, fit-testing, periodic environmental monitoring, maintenance, inspection, cleaning, and convenient, sanitary storage areas.

Protective Clothing/Equipment: Wear chemically protective gloves, boots, aprons, and gauntlets made of butyl rubber to prevent prolonged or repeated skin contact. Wear protective eyeglasses or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133). Because contact lens use in industry is controversial, establish your own policy.

Safety Stations: Make available in the work area emergency eyewash stations, safety/quick-drench showers, and washing facilities.

Contaminated Equipment: Separate contaminated work clothes from street clothes. Launder before reuse. Remove this material from your shoes and clean personal protective equipment.

Comments: Never eat, drink, or smoke in work areas. Practice good personal hygiene after using this material, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

Section 9 - Physical and Chemical Properties

Physical State: Solid

Appearance and Odor: White to gray crystals or powder which is odorless or has a slight aromatic odor.

Odor Threshold: 5.0725 mg/m^3

Vapor Pressure: 5.5×10^{-6} mm Hg at 68 °F (20 °C)

Formula Weight: 354.48

Specific Gravity (H_2O=1, at 4 °C): 0.98 to 0.99

Water Solubility : 0.0012 ppm

Other Solubilities (g DDT/100 mL): acetone 58, 95% alcohol 2, benzene 78, benzyl benzoate 42, carbon tetrachloride 45, chlorobenzene 74, cyclohexanone 116, dibutyl phthalate 33, o-dichlorobenzene 68, dichlorodifluoromethane 2, dioxane 100, ethyl ether 28, gasoline 10, isopropanol 3, kerosine 8 to 10, methylated naphthalenes 40 to 60, mineral oil 5, morpholine 75, peanut oil 11, pine oil 0 to 16, tetralin 61, tributyl phosphate 50, and xylene 60.

Boiling Point: 365 °F (185 °C)

Melting Point: 227 °F (108.3 °C)

Section 10 - Stability and Reactivity

Stability: DDT is stable at room temperature in closed containers under normal storage and handling conditions. It biodegrades very slowly.

Polymerization: Hazardous polymerization does not occur.

Chemical Incompatibilities: Strong oxidizers, alkaline materials, iron and aluminum salts.

Conditions to Avoid: Exposure to heat, ignition sources, and incompatibles.

Hazardous Decomposition Products: Thermal oxidative decomposition of DDT can produce carbon dioxide.

Section 11- Toxicological Information

Toxicity Data:*

Eye Effects: None reported.

Skin Effects: None reported.

Acute Oral Effects:
Human, oral, LD_{Lo}: 500 mg/kg caused convulsions, cardiac arrhythmias, and respiratory changes.
Rat, oral, LD_{50}: 87 mg/kg; details not reported

Carcinogenicity: Rat, oral, TD_{Lo}: 1225 mg/kg given for 7 continuous weeks caused liver tumors.

Mutagenicity: *E. coli*: 15 µmol/L caused DNA damage.

Teratogenicity: Rat, oral, TD_{Lo}: 112 mg/kg given to a 56 day old male caused paternal effects (spermatogenesis, testes, epididymis, sperm duct).

* See NIOSH, *RTECS* (KJ3325000), for additional toxicity data.

Section 12 - Ecological Information

Ecotoxicity: Glass shrimp (*Palaemonestes kadiakensis*), LC_{50} = 2.3 mcg/L/96 hr at 69.8 °F (21 °C); Japanese quail, 2 month old male, (*Coturnix japonica*), LD_{50} = 841 mg/kg; bluegill (*Lepomis macrochirus*), LC_{50} = 28.7 mcg/L/36 hr.

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Environmental Degradation: In water, DDT will adsorb strongly to sediments, significantly bioconcentrate in fish, and will be subject to considerable evaporation with an estimated half-life of several hr to almost 50 hr from certain waters. It may biodegrade when high concentrations of required microbes (*Escherichia*, *Hydrogenomonas*, and *Saccharomyces*) are present. On land, DDT will adsorb strongly and should not appreciably leach to groundwater. It may evaporate (half-life of 100 days) and is subject to photooxidation from soil. DDT may significantly biodegrade in flooded soils or under anaerobic conditions provided high populations of the required microbes are present. Half-life ranges from 2 to >15 yr. In the air, DDT is subject to direct photooxidation and reaction with photochemically produced hydroxyl radicals (est. half-life = 2 days). Wet and dry deposition are significant mechanisms for removal from air.

Section 13 - Disposal Considerations

Disposal: DDT is a good candidate for rotary kiln or liquid injection incineration (furnace with afterburner and alkali scrubber). 60 to 80% removal of DDT from contaminated soils has been achieved in 10 min. by super critical-carbon dioxide extraction. Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.

Container Cleaning and Disposal: Triple rinse containers. Containers in good condition should be returned to the manufacturer and those that are not reusable should be punctured and transported to a scrap metal facility for recycling, disposal, or burial in a designated landfill.

Section 14 - Transport Information

DOT Transportation Data (49 CFR 172.101):

Shipping Name: Organochlorine pesticides, solid toxic, n.o.s.
Shipping Symbols: —
Hazard Class: 6.1
ID No.: UN2761
Packing Group: III
Label: Keep Away From Food
Special Provisions (172.102): —

Packaging Authorizations
a) Exceptions: 173.153
b) Non-bulk Packaging: 173.213
c) Bulk Packaging: 173.240

Quantity Limitations
a) Passenger, Aircraft, or Railcar: 100 kg
b) Cargo Aircraft Only: 200 kg

Vessel Stowage Requirements
a) Vessel Stowage: A
b) Other: 40

Section 15 - Regulatory Information

EPA Regulations:
RCRA Hazardous Waste Number (40 CFR 261.33): U061
Listed as a RCRA Hazardous Waste Classification (40 CFR 261.33)
Listed as a CERCLA Hazardous Substance (40 CFR 302.4) per RCRA, Sec. 3001; CWA, Sec. 311 (b)(4); and CWA, Sec. 307(a)
CERCLA Reportable Quantity (RQ), 1 lb (0.454 kg)
SARA Toxic Chemical (40 CFR 372.65): Not listed
SARA EHS (Extremely Hazardous Substance) (40 CFR 355): Not listed
OSHA Regulations:
Listed as an Air Contaminant (29 CFR 1910.1000, Table Z-1, Z-1-A)

Section 16 - Other Information

References: 73, 101, 103, 124, 126, 127, 132, 133, 136, 139, 148, 153, 167, 168, 169, 176, 180, 183

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Industrial Hygiene Review ..... PA Roy, MPH, CIH
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Section 1 - Chemical Product and Company Identification 45

Product/Chemical Name: Diazinon
Chemical Formula: $C_{12}H_{21}N_2O_3PS$ or $[C(CH_3)_2CHC_4N_2H(CH_3)O]PS(OC_2H_5)_2$
CAS No.: 333-41-5
Synonyms: Alfa-Tox; Basudin; Diazide; Diazol; diethyl-2-isopropyl-4-methyl-6-pyrimidinyl phosphorothionate; Dimplyate; Dipofene; Dyzol; Exodin; Garden Tox; Geigy 24480; isopropylmethylpyrimidyl diethyl thiophosphate; Kayazinon; Kayazol; NCI-CO8673; Neocidol; O, O-diethyl-2-isopropyl-4-methylpyrimidyl-6-thiophosphate; oleodiazinon; phosphorothioate, O, O-diethyl, O-6-(2-isopropyl-4-methylpyrimidyl); Spectracide; thiophosphoric acid, 2-isopropyl-4-methyl-6-pyrimidyl diethyl ester
Derivation: Produced by reacting 2-isopropyl-4-hydroxy-6-methyl-pyrimidine and O, O-diethylphosphorochloridothioate.
General Use: Used as an acaricide and insecticide in agriculture and for home and garden use.
Vendors: Consult the latest *Chemical Week Buyers' Guide.* (73)

Section 2 - Composition / Information on Ingredients

Diazinon, ca 100 % vol

OSHA PEL
Vacated 1989 Final Rule limit
8-hr TWA: 0.1 mg/m^3, *skin*

ACGIH TLV
TWA: 0.1 mg/m^3, *skin*

NIOSH REL
10-hr TWA: 0.1 mg/m^3, *skin*

DFG (Germany) MAK
TWA: 1.0 mg/m^3, *skin*
Category III: Substances with systemic effects
Onset of Effect: > 2 hr
Half-life: > shift length (strongly cumulative)

Peak Exposure Limit:
10 mg/m^3, 30 min. average value, 1/shift

Section 3 - Hazards Identification

☆☆☆☆☆ Emergency Overview ☆☆☆☆☆

Diazinon exists as a colorless liquid when pure and the technical grade appears pale yellow to dark brown with a faint, ester-like odor. As an insecticide for both agriculture and home use, diazinon has resulted in a substantial number of poisonings. Diazinon inhibits the enzyme *cholinesterase* and, therefore, exerts much of its toxicity on the central nervous system. The respiratory system may be severely compromised and various problems with the eyes may occur. It is readily absorbed through the skin. Pure diazinon is very difficult to burn, but in solution, it becomes readily combustible (depending upon solvent).

Wilson Risk Scale
R 1
I 4
S 2*
K 0†
*Skin absorption
†pure

HMIS
H 3*
F 0†
R 0
*Chronic effects
†2 -3 for solutions
PPE‡
‡Sec. 8

Potential Health Effects

Primary Entry Routes: Inhalation, ingestion, eye and skin contact/absorption.
Target Organs: Eyes, respiratory system, central nervous system, cardiovascular system, blood cholinesterase.
Acute Effects
Inhalation: Symptoms include weakness, headache, nausea and vomiting, excessive salivation and sweating, dizziness, abdominal cramps, blurred vision, non-reactive pinpoint pupils, incoordination, slurred speech, bronchorrhea (excessive discharge of mucous from the air passages of the lungs) which produce moist rales (abnormal sound in the lungs caused by breathing through mucous-clogged passages), bronchospasm (constriction of the air passages of the lung by spasmodic contraction of the bronchial muscles - as seen in asthma), pulmonary edema (fluid in the lungs), muscle twitching (especially of the tongue and eyelids), convulsions, and death.
Eye: Contact causes severe irritation.
Skin: Contact may cause irritation. Diazinon is readily absorbed through the skin to cause central nervous system and respiratory effects (see inhalation).
Ingestion: Gastrointestinal tract irritation may occur followed by symptoms as via inhalation.
Carcinogenicity: IARC, NTP, and OSHA do not list diazinon as a carcinogen.
Medical Conditions Aggravated by Long-Term Exposure: Central nervous system, respiratory, and eye disorders.
Chronic Effects: Repeated exposure can cause ocular disorders collectively referred to as "Saku disease" and characterized by decreased visual acuity (detail, clarity) in both eyes, narrow field of vision, anomaly of refraction and enhanced tendon reflexes; paresthesia (tingling, burning sensation of the skin), weakness in the legs, thirst, constipation, headache, constant fatigue, orthostatic anemia (anemia that only occurs when a person is in the upright position and disappears when the person lies down for a short time), rectal disturbances, and impotence.

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Other: Although estimates on the human fatal dose have been made (25 mg/kg) and the NOEL (no observed effect level) is set at 0.02 mg/kg/day, these amounts may not accurately reflect the toxic potential of diazinon. There appears to be great variation in sensitivity/tolerance to diazinon. For example, a patient who ingested 30 mg/kg showed no symptoms whereas 2 patients dermally exposed to 1.1 mg/kg were severely poisoned. Teratogenic effects have been reported in animals (Sec. 11).

Section 4 - First Aid Measures

Inhalation: Remove exposed person to fresh air and support breathing as needed.

Eye Contact: *Do not* allow victim to rub or keep eyes tightly shut. Gently lift eyelids and flush immediately and continuously with flooding amounts of water until transported to an emergency medical facility. Consult a physician or ophthalmologist immediately.

Skin Contact: *Quickly* remove contaminated clothing. Rinse with flooding amounts of water followed by three washes: soap and water, 95% ethanol, followed by a second soap and water wash. Wash hair and nails. Tincture of green soap which contains 30% ethanol can be used. For reddened or blistered skin, consult a physician.

Ingestion: Never give anything by mouth to an unconscious or convulsing person. Contact a poison control center. Unless the poison control center advises otherwise, have the *conscious and alert* person drink 1 to 2 glasses of water to dilute. Inducement of vomiting is contraindicated because of the possible early onset of respiratory depression and convulsions. Gastric lavage should be considered, followed by administration of activated charcoal in a slurry.

After first aid, get appropriate in-plant, paramedic, or community medical support.

Note to Physicians: Support respiratory and cardiovascular function. Albuminuria and hematuria may be seen. In seriously poisoned patients, treatment with atropine may be necessary: administer 0.4 to 2.0 mg every 15 to 30 min until atropinization is achieved. Keep under observation, symptoms develop from within minutes up to 12 hr.

Section 5 - Fire-Fighting Measures

Flash Point: 82 to 105 °F (27.7 to 40.5 °C), *solutions only, temperature depends upon solvent*; pure diazinon does not burn.

Flash Point Method: CC

Burning Rate: 4 mm/min (solutions)

Autoignition Temperature: None reported.

LEL: None reported.

UEL: None reported.

Flammability Classification: Class IC flammable liquid or Class II combustible liquid, depending on solvent used for solution. Pure diazinon is not combustible.

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*2 - 3 for solutions

Extinguishing Media: For small fires, use dry chemical, carbon dioxide, water spray, or regular foam. For large fires, use water spray, fog, or regular foam.

Unusual Fire or Explosion Hazards: Container may explode in heat of fire.

Hazardous Combustion Products: Include carbons oxide(s), nitrogen oxide(s), sulfur oxide(s), and phosphorus oxide(s).

Fire-Fighting Instructions: Fight fire from maximum distance. Stay away from ends of tanks. Do not release runoff from fire control methods to sewers or waterways.

Fire-Fighting Equipment: Because fire may produce toxic thermal decomposition products, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in pressure-demand or positive-pressure mode. Structural firefighters' protective clothing is *not* effective against diazinon. Use clothing specifically recommended by manufacturer but be aware that it may provide little or no thermal protection.

Section 6 - Accidental Release Measures

Spill /Leak Procedures: Notify safety personnel, isolate and ventilate area, deny entry, and stay upwind. Shut off all ignition sources. Cleanup personnel should wear fully-encapsulated, vapor-protective clothing. Treat spill with an *alkaline* material such as soda ash, baking soda, slaked lime, or limestone, or add a strong detergent. Never use bleach and ammonia as highly toxic chloramine gas will evolve.

Small Spills: Take up with earth, sand, vermiculite, or other absorbent, noncombustible material and place in suitable containers for later disposal.

Large Spills

Containment: For large spills, dike far ahead of liquid spill for later disposal. Do not release into sewers or waterways.

Cleanup: Damp mop any residue with an alkaline solution (see above).

Regulatory Requirements: Follow applicable OSHA regulations (29 CFR 1910.120).

Section 7 - Handling and Storage

Handling Precautions: Use protective clothing when working with diazinon. Avoid vapor inhalation and skin or eye contact.

Storage Requirements: Diazinon has a shelf-life of at least 3 to 5 yr when stored in a dry area. Store in a cool, dry, well-ventilated area away from heat, ignition sources and incompatibles (Sec. 10).

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Section 8 - Exposure Controls / Personal Protection

Engineering Controls: Enclose processes where possible to prevent dispersion of sprays or mists into work area.
Ventilation: Provide general or local exhaust ventilation systems to maintain airborne concentrations as low as possible. Local exhaust ventilation is preferred because it prevents contaminant dispersion into the work area by controlling it at its source.(103)
Administrative Controls: Consider preplacement and periodic medical exams of exposed workers with emphasis of the central nervous system, respiratory system, and eyes. Check blood cholinesterase levels regularly.
Respiratory Protection: Seek professional advice prior to respirator selection and use. Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, wear a MSHA/NIOSH-approved respirator. Select respirator based on its suitability to provide adequate worker protection for given working conditions, level of airborne contamination, and presence of sufficient oxygen. NIOSH is in the process of designing specific respirator guidelines for diazinon. For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), wear an SCBA. *Warning! Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.* If respirators are used, OSHA requires a written respiratory protection program that includes at least: medical certification, training, fit-testing, periodic environmental monitoring, maintenance, inspection, cleaning, and convenient, sanitary storage areas.
Protective Clothing/Equipment: Wear chemically protective gloves, boots, aprons, and gauntlets to prevent prolonged or repeated skin contact. Neoprene has been suggested as a suitable material for PPE. Do not wear any leather clothing when working with diazinon because it (as do all organophosphate pesticides) becomes concentrated in the leather. Wear protective eyeglasses or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133). Contact lenses are not eye protective devices. Appropriate eye protection must be worn instead of, or in conjunction with contact lenses.
Safety Stations: Make emergency eyewash stations, safety/quick-drench showers, and washing facilities available in work area.
Contaminated Equipment: Separate contaminated work clothes from street clothes. Contaminated clothing may have to be disposed of by incineration instead of laundering because of the difficulty in removal.
Comments: Never eat, drink, or smoke in work areas. Practice good personal hygiene after using diazinon, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

Section 9 - Physical and Chemical Properties

Physical State: Liquid
Appearance and Odor: Colorless (pure) or pale yellow to dark brown with an ester-like odor.
Vapor Pressure: 1.4×10^{-4} mm Hg at 68 °F (20 °C)
Formula Weight: 304.36
Specific Gravity (H_2O=1, at 4 °C): 1.116 - 1.118 at 68 °F (20 °C)
Water Solubility: 0.004% at 68 °F (20 °C)
Other Solubilities: Soluble in alcohol, acetone, benzene, cyclohexane, ether, and xylene.
Boiling Point: 183.2 °F (84 °C) at 0.002 mm Hg, decomposes at 248 °F (120 °C)
Refractive Index: 1.4978 to 1.4981
Surface Tension: 35 dyne/cm at 68 °F (20 °C), est.
Volatility: 2.4 mg/m^3 at 68 °F (20 °C), 17.6 mg/m^3

Section 10 - Stability and Reactivity

Stability: Diazinon is stable at room temperature in closed containers under normal storage and handling conditions. It is sensitive to oxidation above 100 °C and decomposes above 120 °C.
Polymerization: Hazardous polymerization does not occur.
Chemical Incompatibilities: Diazinon is incompatible with copper-containing compounds. It slowly hydrolyzes in dilute acids and decomposes when exposed to strong acids or alkalis.
Conditions to Avoid: Exposure to high temperatures (> 194 °F/> 90 °C) and incompatibles.
Hazardous Decomposition Products: Include carbon, nitrogen, sulfur, and phosphorus oxides.

Section 11- Toxicological Information

Toxicity Data:*

Eye Effects:
Rabbit, eye: 100 mg caused severe irritation.
Skin Effects:
Rabbit, skin (open patch test): 500 mg caused moderate irritation.
Acute Dermal Effects:
Rat, skin, LD_{50}: 180 mg/kg
Teratogenicity:
Rat, oral: 26.4 mg/kg (12 to 15 days of pregnancy) caused specific developmental abnormalities of the urogenital system.
Mutagenicity:
Human, lymphocyte: 500 µg/L caused mutation.
Acute Inhalation Effects:
Rat, inhalation, LC_{Lo}: 3500 mg/m^3/4 hr
Mouse, inhalation, LC_{50}: 1600 mg/m^3/4 hr
Acute Oral Effects:
Rat, oral, LD_{50}: 66 mg/kg
Human, oral, TD_{Lo}: 214 mg/kg caused change in motor activity, muscle weakness, and sweating.
Multiple Dose Toxicity Data:
Dog, oral: 4900 mg/kg administered intermittently for 35 weeks caused gastrointestinal changes, blood changes (including RBC count), and multiple enzyme effects.

* See NIOSH, *RTECS* (TF3325000), for additional toxicity data.

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Section 12 - Ecological Information

Ecotoxicity: Rainbow trout, LC_{50} = 0.38 ppm/24 hr; fathead minnow (*Pimephales promelas*), LC_{50} = 9.35 mg/L/96 hr.

Environmental Degradation: If released to soil, diazinon is not expected to adsorb, but will be mobile and may leach to groundwater. It will undergo hydrolysis at pH <6. Photolysis may occur at the surface, but biodegradation is expected to be the most important removal process (reported half-lives of < 1 to 5 weeks). Overall persistence in soils is reported at 3 to 14 weeks. In water, diazinon will undergo hydrolysis with reported half-lives of 31 days (pH 5), 185 days (pH 7.4), and 136 days (pH 9) at 68 °F (20 °C) and 2 to 3 weeks in distilled water. The two major hydrolysis products are 2-isopropyl-4-methyl-6-hydroxypyrimidine and diethyl thiophosphoric acid or diethyl phosphoric acid. Biodegradation and photolysis may also occur. Evaporation from a model river 1 meter deep, flowing 1 meter/sec., with a wind velocity of 3 meter/sec has an estimated half-life of 46 days. In the air, diazinon is expected to exist in the vapor-phase with a half-life of 4.83 hr via reaction with photochemically-produced hydroxyl radicals. It may also be subjected to direct photolysis by absorbing light at > 290 nm.

Section 13 - Disposal Considerations

Disposal: Place small amounts in container and add an alkaline agent (sodium bicarbonate, soda ash, lime) to hydrolyze the diazinon to the alkaline salt of diethylthiophosphoric acid and 2-isopropyl-4-methyl-6-hydroxypyrimidine. Dispose of large amounts in an approved incinerator equipped with effluent gas scrubbers. Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.

Container Cleaning and Disposal: Triple rinse containers using alkali or detergent (in water) described above. Dispose of rinse water as above.

Section 14 - Transport Information

DOT Transportation Data (49 CFR 172.101):

Shipping Name:
Organophosphorus pesticides, solid, toxic, n.o.s.
Shipping Symbols: –
Hazard Class: 6.1
ID No.: UN2783
Packing Group: III
Label: Keep Away From Food
Special Provisions (172.102): N77

Packaging Authorizations
a) Exceptions: 173.153
b) Non-bulk Packaging: 173.213
c) Bulk Packaging: 173.240

Quantity Limitations
a) Passenger, Aircraft, or Railcar: 100 kg
b) Cargo Aircraft Only: 200 kg

Vessel Stowage Requirements
a) Vessel Stowage: A
b) Other: 40

Section 15 - Regulatory Information

EPA Regulations:
RCRA Hazardous Waste (40 CFR 261.33): Not listed
Listed as a CERCLA Hazardous Substance (40 CFR 302.4) per CWA Sec. 311(b)(4)
CERCLA Reportable Quantity (RQ), 1.0 lb (0.454 kg)
SARA Toxic Chemical (40 CFR 372.65): Not listed
SARA EHS (Extremely Hazardous Substance) (40 CFR 355): Not listed

OSHA Regulations:
Listed as an Air Contaminant (29 CFR 1910.1000, Table Z-1-A, *Vacated 1989 Final Rule Limits*)

Section 16 - Other Information

References: 73, 103, 124, 136, 176, 189, 190, 192, 197, 201, 203

Prepared By ..... M Gannon, BA
Industrial Hygiene Review ..... PA Roy, MPH, CIH
Medical Review ..... T Thoburn, MD, MPH

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Section 1 - Chemical Product and Company Identification 48

Product/Chemical Name: 2,4-D
Chemical Formula: $Cl_2C_6H_3OCH_2COOH$; $C_8H_6Cl_2O_3$
CAS Number: 94-75-7
Other Designations: Agrotect, Amidox, Bladex-B, Brush Killer 64, Chipco Turf Herbicide, Crop Rider, Ded-Weed; 2,4-dichlorophenoxyacetic acid; Dicopur; DMA-4; Esteron, Farmco; Fernimine; Hivol-44; Ipaner; Krotiline; Lawn-Keep; Monosan; Planotox; Verton D; Weed-AG-Bar; Weedtox
Derivation: By the reaction of 2,4-dichlorophenol and chloroacetic acid in aqueous sodium hydroxide.
General Use: As a selective weed killer and defoliant, a plant growth regulator, and for fruit drop control. Its use may be restricted. **Vendors:** Consult the latest *Chemical Week Buyers' Guide.* (73)

Section 2 - Composition / Information on Ingredients

2,4-D, ca 100 %wt
Trace Impurities: 2,6-dichlorophenoxyacetic acid, 0.5-1.5%; 2-monochlorophenoxyacetic acid, 0.1-0.5%; 4-monochlorophenoxy-acetic acid, 0.2-0.8%; bis(2,4-dichlorophenoxy) acetic acid, 0.1-2.0%; 2-chlorophenol, 0.0004-0.04%; 4-chlorophenol 0.0004-0.005%; water, 0.1-0.8%.

OSHA PEL
8-hr TWA: 10 mg/m^3

ACGIH TLV
TWA: 10 mg/m^3

NIOSH REL
10-hr TWA: 10 mg/m^3

IDLH Level
500 mg/m^3

DFG (Germany) MAK
TWA: 10 mg/m^3
Category II: Substances with systemic effects, onset of effect ≤ 2 hr, half-life 2 hr-shift length

Peak Exposure Limit:
50 mg/m^3, 30 min, average value, 2 per shift

Section 3 - Hazards Identification

☆☆☆☆☆ Emergency Overview ☆☆☆☆☆

2,4-D is a white to yellow (impure) crystalline powder which is odorless when pure and has a slight phenolic odor when impure. It is a skin, eye, and respiratory tract irritant, a neurotoxin, and can cause liver and kidney injury. 2,4-D is a possible human carcinogen. *Handle with extreme caution!*

Wilson Risk Scale
R 1
I 2
S 2*
K 0
*Skin absorption

HMIS
H 3*
F 0
R 0

*Chronic Effects
PPE†
†Sec. 8

Potential Health Effects

Primary Entry Routes: Inhalation, skin and eye contact, skin absorption, and ingestion.
Target Organs: Respiratory tract, skin, eyes, kidneys, liver, central nervous system, and gastrointestinal tract.
Acute Effects
Inhalation: Throat and respiratory tract irritation with a burning feeling. Other systemic effects include nausea, vomiting, headache, dizziness, poor appetite, sweating, fever, diarrhea, low urine output, and loss of coordination. Delayed effects (2-3 weeks) on the nervous system may occur causing polyneuritis (with paresthesia and anesthesia), weakness, stiffness, and poor coordination of the arms and legs. Hemorrhagic enterocolitis (inflammation with bleeding of the small and large intestines) may also develop.
Eye: Irritation, alteration of color vision, and miosis (pinpoint pupils).
Skin: Irritation, rash, and dermatitis upon prolonged exposure.
Ingestion: Irritation and burning pain of the mouth, throat, and gastrointestinal tract, vomiting, flushed skin, twitching, fever or abnormal temperature, weakness, paralysis, congestion (abnormal pooling of blood) of internal organs, pulmonary edema (fluid in lungs), damage to the liver, kidneys, and brain, progressively lower blood pressure, vascular collapse, and death due to ventricular fibrillation (irregular twitching of the heart). A 46 yr old farmer who accidentally ingested 2,4-D experienced a loss of sexual potency for about 4 months after the exposure.
Carcinogenicity: IARC lists 2,4-D as Group 2-B (possibly carcinogenic to humans: limited evidence in humans in the absence of sufficient evidence in experimental animals). The NTP and OSHA do not list 2,4-D as a carcinogen.
Medical Conditions Aggravated by Long-Term Exposure: Disorders of the skin, liver, kidneys, and respiratory and central nervous systems.
Chronic Effects: Chronic exposure may lead to dermatitis, lung effects (airway narrowing, emphysema), liver and kidney damage, and central nervous system defects in motor function control.

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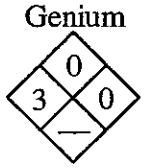
Other: 2,4-D may cause mutagenic, teratogenic (Sec. 11), and reproductive effects (see effects via ingestion).

Section 4 - First Aid Measures

Inhalation: Remove exposed person to fresh air, monitor for respiratory distress, and support breathing as needed.
Eye Contact: *Do not* allow victim to rub or keep eyes tightly shut. Gently lift eyelids and flush immediately and continuously with flooding amounts of water for at least 15 min. Consult a physician or ophthalmologist if pain or irritation develop.
Skin Contact: *Quickly* remove contaminated clothing. Rinse with flooding amounts of water for at least 15 min. Wash exposed area including hair and nails with soap and water. Do repeated soap washings. For reddened or blistered skin, consult a physician.
Ingestion: Spontaneous vomiting may occur. Never give anything by mouth to an unconscious or convulsing person. Contact a poison control center. Unless the poison control center advises otherwise, have the *conscious and alert* person drink 1 to 2 glasses of water, then induce vomiting.
Note to Physicians: Obtain a baseline CBC, and renal and hepatic function tests. Test urine for RBC, protein, and myoglobin. Monitor urine output. Follow LDH, SGOT, and alkaline phosphatase to detect liver injury, and CPK to detect muscle damage. Measure arterial pH, urine pH, and bicarbonate to detect acidosis. If myoglobinuria is present, induce alkaline diuresis. Use cautiously in the presence of renal dysfunction. This may also enhance elimination. Also monitor patient closely for cardiac arrhythmias, hyperthermia, and seizures. **Special Precautions/Procedures:** Emergency personnel should protect against contamination when aiding exposure victims.

Section 5 - Fire-Fighting Measures

Genium



Flash Point: None reported.
Autoignition Temperature: None reported.
LEL: None reported.
UEL: None reported.
Extinguishing Media: Use extinguishing media appropriate to surrounding fire. **Unusual Fire or Explosion Hazards:** Containers may explode in the heat of fire. **Hazardous Combustion Products:** Phosgene, hydrogen chloride, carbon monoxide, and chlorides. **Fire-Fighting Instructions:** If feasible and without unnecessary risk, move containers from fire hazard area. Do not release runoff from fire control methods to sewers or waterways. **Fire-Fighting Equipment:** Because fire may produce toxic thermal decomposition products, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in pressure-demand or positive-pressure mode. Structural firefighters' protective clothing is *not* effective.

Section 6 - Accidental Release Measures

Spill /Leak Procedures: Notify safety personnel, evacuate unnecessary personnel, and isolate and ventilate area. Shut off heat and ignition sources. Cleanup personnel should protect against any exposure.
Small Spills: Carefully scoop up spilled 2,4-D and place in appropriate containers for disposal or reclamation. Avoid dust dispersion; *do not* sweep! Use a vacuum with a HEPA filter or wet mop.
Large Spills
Containment: For large spills, dike far ahead of liquid spill for later disposal. Do not release into sewers or waterways.
Regulatory Requirements: Follow applicable OSHA regulations (29 CFR 1910.120).

Section 7 - Handling and Storage

Handling Precautions: Reduce all exposure to the lowest possible level. Use sufficient ventilation to reduce airborne concentrations to nonhazardous levels. Wear personal protective equipment and clothing to avoid any contact with skin and eyes. To avoid inadvertently ingesting 2,4-D, practice good personal hygiene procedures. **Storage Requirements:** Store in tightly closed and appropriately labeled containers in a cool, dry, well-ventilated area away from heat and ignition sources, oxidizers, and other agrochemicals or seeds.

Section 8 - Exposure Controls / Personal Protection

Engineering Controls: Where feasible, enclose all operations to avoid dust dispersion into the work area.
Ventilation: Provide general or local exhaust ventilation systems to maintain airborne concentrations at the lowest possible level. Local exhaust ventilation is preferred because it prevents contaminant dispersion into the work area by controlling it at its source. **Administrative Controls:** Consider preplacement and periodic medical exams with emphasis on the respiratory tract, skin, liver, kidneys, and cardiovascular and central nervous systems. Educate workers about the hazards of 2,4-D and train in safe work practices which minimize exposure. **Respiratory Protection:** Seek professional advice prior to respirator selection and use. Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, wear a MSHA/NIOSH-approved respirator. Select respirator based on its suitability to provide adequate worker protection for given working conditions, level of airborne

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contamination, and presence of sufficient oxygen. At any exposure level, wear a supplied-air respirator with a full facepiece operated in the positive-pressure mode or with a full facepiece, hood, or helmet in the continuous-flow mode, or a SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode. For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), wear an SCBA. *Warning! Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.* If respirators are used, OSHA requires a written respiratory protection program that includes at least: medical certification, training, fit-testing, periodic environmental monitoring, maintenance, inspection, cleaning, and convenient, sanitary storage areas. **Protective Clothing/Equipment:** Wear chemically protective gloves, boots, aprons, and gauntlets to prevent skin contact. Recommended materials for PPE include natural rubber, neoprene, nitrile rubber, and polyvinyl chloride (all with break through times >8 hr). *Do not* wear leather. Wear protective eyeglasses or chemical dust- and splash-proof, safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133). Contact lenses are not eye protective devices. Appropriate eye protection must be worn instead of, or in conjunction with contact lenses. **Safety Stations:** Make emergency eyewash stations, safety/quick-drench showers, and washing facilities available in work area. **Contaminated Equipment:** Separate contaminated work clothes from street clothes. Launder before reuse. Remove 2,4-D from your shoes and clean personal protective equipment. **Comments:** Never eat, drink, or smoke in work areas. Practice good personal hygiene after using 2,4-D, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

Section 9 - Physical and Chemical Properties

Physical State: Solid
Appearance and Odor: White to yellow (impure) crystalline powder which is odorless when pure and has a slight phenolic odor when impure.
Odor Detection: 3.13 mg/kg
Vapor Pressure: 53 Pa at 320 °F (160 °C)
Formula Weight: 221.04
Density: 1.416 at 77 °F (25 °C)
Boiling Point: 320 °F (160 °C) at 0.4 mm Hg
Melting Point: 280 °F(138 °C)
Henry's Law Constant: 1.02 x 10^{-8} atm-cm^3/mol

Water Solubility: 620 mg/L at 68 °F (20 °C)
Other Solubilities: Soluble in alcohol. (g of 2,4-D/100 g of solvent at 25 °C unless otherwise stated): 85.0 g/acetone, 1.07/benzene at 28 °C, 0.5 g/carbon disulfide at 29 °C, 0.1 g/carbon tetrachloride, 0.10 to 0.35 g/diesel oil and kerosene, 78.5 g/dioxane, 10.3 g/ethanol (50%), 130.0 g/ethyl alcohol, 27.0g/ethyl ether, 31.6 g/isopropanol at 31 °C, 31.27 g/methyl isobutyl ketone, 0.4 g/toluene, 0.58 g/xylene.
Octanol Water Partition Coefficient: log Kow= 2.81
pH: weak acid (Ka= 2.3 x 10^{-3})
Surface Tension: 66.5 dyne/cm at 77 °F (25 °C) and pH 1.4

Section 10 - Stability and Reactivity

Stability: 2,4-D is stable up to 122 °F (50 °C) for at least 2 yr at room temperature in closed containers under normal storage and handling conditions. **Polymerization:** Hazardous polymerization cannot occur. **Chemical Incompatibilities:** Strong oxidizers. When 2,4-D is pure, it is corrosive to metals. **Conditions to Avoid:** Avoid heat and ignition sources and oxidizers. **Hazardous Decomposition Products:** Thermal oxidative decomposition of 2,4-D can produce hydrogen chloride, phosgene, carbon monoxide, and chlorides.

Section 11- Toxicological Information

Toxicity Data:*

Eye Effects: Rabbit: 750 µg/24 hr caused severe irritation.
Skin Effects: Rabbit: 500 mg/24 hr caused mild irritation.
Acute Inhalation Effects: Human, oral, LD_{Lo}: 80 mg/kg caused nausea, vomiting, and somnolence.
Acute Dermal Effects: Rabbit, skin, LD_{50}: 1400 mg/kg
Acute Oral Effects:
Man, oral, TD_{Lo}: 2 g/kg caused coma and respiratory depression.
Rat, oral, LD_{50}: 375 mg/kg
Teratogenicity:
Rat, oral: 125 mg/kg administered to a female during 6-15 day of pregnancy caused specific developmental abnormalities of the musculoskeletal system.
Mutagenicity:
Human, fibroblast: 1 µmol/L caused unscheduled DNA synthesis.
Human, lymphocyte: 10 mg/L caused sister chromatid exchange.
Other Multiple Dose Toxicity:
Rat, oral: 200 mg/kg/5 weeks/ administered intermittently caused muscle weakness

* See NIOSH, *RTECS* (AG6825000), for additional toxicity data.

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Section 12 - Ecological Information

Ecotoxicity: *Salmo clarki* (cutthroat trout), LC_{50}: 64 mg/L/96 hr; *Lepomis macrochirus* (bluegill fish), LC_{50}: 0.9 ppm/48 hr; *Anguilla rostrata* (American eel), LC_{50}: 300.6 mg/L/96 hr. **Environmental Fate:** In the atmosphere, 2,4-D will be subject to photo-oxidation by reaction with hydroxyl radicals with an estimated half-life of 1 day. Rain-out and gravitational settling of aerosol may also be significant removal processes. There is little tendency for 2,4-D to bioconcentrate. Volatilization from water and soil is expected to be negligible. **Environmental Degradation:** Biodegradation is the most important loss process for 2,4-D in most soils, leading to various hydroxylic aromatic products. Typical half-lives range from less than 1 day to several weeks. When released to water, 2,4-D will also tend to biodegrade (typical half-lives of 10 to >50 days) with the rate especially dependent upon the level of nutrients present, availability of oxygen, temperature, and whether or not there was a prior history of contamination by 2,4-D or other phenoxyacetic acids. **Soil Absorption/Mobility:** Adsorption to soil will probably not be significant, but will depend on the type of soil and organic content.

Section 13 - Disposal Considerations

Disposal: Incinerate at high temperatures with sufficient residence times. PCDDs may be formed if not incinerated at high enough temperatures. Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations. **Disposal Regulatory Requirements:** Triple rinse (with a 5% solution of caustic soda) and drain containers. **Container Cleaning and Disposal:** Handle empty containers carefully as hazardous residues may still remain.

Section 14 - Transport Information

DOT Transportation Data (49 CFR 172.101):

Shipping Name:
Phenoxypesticides, solid, toxic
Shipping Symbols: —
Hazard Class: 6.1
ID No.: UN2765
Packing Group: III
Label: Keep Away From Food
Special Provisions (172.102): —

Packaging Authorizations
a) Exceptions: 173.153
b) Non-bulk Packaging: 173.213
c) Bulk Packaging: 173.240

Quantity Limitations
a) Passenger, Aircraft, or Railcar: 100 kg
b) Cargo Aircraft Only: 200 kg

Vessel Stowage Requirements
a) Vessel Stowage: A
b) Other: 40

Section 15 - Regulatory Information

EPA Regulations:
Listed as a RCRA Hazardous Waste (40 CFR 261.33)
RCRA Hazardous Waste Number: U240
CERCLA Hazardous Substance (40 CFR 302.4) listed per RCRA, Sec. 3001; CWA, Sec. 311 (b)(4); CAA, Sec. 112
CERCLA Reportable Quantity (RQ), 100 lb (45.4 kg)
Listed as a SARA Toxic Chemical (40 CFR 372.65)
SARA EHS (Extremely Hazardous Substance) (40 CFR 355): Not listed
OSHA Regulations:
Listed as an Air Contaminant (29 CFR 1910.1000, Table Z-1)

Section 16 - Other Information

References: 73, 103, 136, 197, 209, 210
Prepared By..... MJ Wurth, BS
Industrial Hygiene Review..... DJ Wilson, CIH
Medical Review..... R Teichman, MD

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Material Safety Data Sheet Collection

2,4,5-Trichlorophenoxyacetic Acid

MSDS No. 942

Date of Preparation: 4/95

Section 1 - Chemical Product and Company Identification 46

Product/Chemical Name: 2,4,5-Trichlorophenoxyacetic acid (2,4,5-T)
Chemical Formula: $C_6H_2Cl_3OCH_2CO_2H$
CAS Number: 93-76-5
Synonyms: acetic acid, (2,4,5-trichlorophenoxy); Brush Rhap; Dacamine; Dinoxol; Esteron 245; Forron; Fortex; Inverton 245; Phortox; Reddon, Reddox; Spontox; Super D Weedone; 2,4,5-T; Transamine; Tributon; Trinoxol; Trioxone; Veon; Weedar
Derivation: Produced by reacting 2,4,5-Trichlorophenol with monochloroacetic acid.
General Use: Formerly used as a plant hormone, herbicide, and defoliant. The EPA has gradually canceled the registration of products containing 2,4,5-T since 1970 with final cancellation in 1985.
Vendors: Consult the latest *Chemical Week Buyers' Guide.* [73]

Section 2 - Composition / Information on Ingredients

2,4,5-Trichlorophenoxyacetic acid, ca >95 %wt
Trace Impurities: 2,3,7,8-tetrachlorodibenzo-*p*-dioxin (TCDD) is found in concentrations from < 0.05 to 0.5 mg/kg. A typical batch of 2,4,5-T from one producer contained > 95% 2,4,5-T; 2 - 9% dichloromethoxyphenoxyacetic acids; 0.6% related trichlorophenoxyacetic acids; 0.5% dichlorophenoxyacetic acids; 0.4% bis 2,4,5-T; and < 0.5 mg/kg TCDD.

OSHA PEL
8-hr TWA: 10 mg/m^3

ACGIH TLV
TWA: 10 mg/m^3

NIOSH REL
10-hr TWA: 10 mg/m^3

IDLH Level
250 mg/m^3

DFG (Germany) MAK
TWA: 10 mg/m^3
Category II: Substances with systemic effects
Onset of Effect: ≤ 2 hr
Half-life: 2 hr to shift length

Peak Exposure Limit:
50 mg/m^3, 30 min. average value, 2/shift

Section 3 - Hazards Identification

☆☆☆☆☆ Emergency Overview ☆☆☆☆☆

2,4,5-Trichlorophenoxyacetic acid exists as white to light tan, odorless crystals. The pure compound is not considered highly toxic, but the commercial product is because it contains a small percentage of the impurity, 2,3,7,8-Tetrachlorodibenzo-*p*-dioxin (TCDD) which is a highly toxic chemical. In general, the toxic effects experienced from exposure to 2,4,5-T may be to a large extent due to TCDD contamination.

Wilson Risk Scale
R 1
I 2
S 1
K 1

HMIS
H 2*
F 0
R 0

* Chronic Effects
PPE†
†Sec. 8

Potential Health Effects

Primary Entry Routes: Inhalation, ingestion, skin and eye contact.
Target Organs: Eyes, skin, gastrointestinal tract, respiratory system, cardiovascular system. The liver and central and peripheral nervous systems may be affected by exposure to TCDD which is a contaminant of 2,4,5-T.
Acute Effects
Inhalation: Irritation of the eyes and respiratory tract.
Eye: Irritation can occur.
Skin: Irritation can occur. Chloracne may develop as a result of contamination by TCDD. 2,4,5-T is slowly absorbed by the skin and may result is systemic effects (see ingestion).
Ingestion: Ingestion of chlorophenoxy compounds in general may cause mouth, throat, and gastrointestinal irritation, chest pain (fromesophagitis), abdominal pain, diarrhea, fibrillary muscle and skeletal muscle twitching, and myotonia (muscle spasms involving prolonged contraction); metabolic acidosis, fever, tachycardia, hyperventilation, vasodilation, and sweating. Contamination with TCDD can cause other effects such as liver function impairment, peripheral neuropathy, and personality changes. The approximate lethal human dose is 4 teaspoonfuls. An acceptable daily intake is 0.03 mg/kg.
Carcinogenicity: IARC classifies 2,4,5-T as Group 2B (possible human carcinogen with limited human evidence and insufficient animal evidence). The NTP and OSHA do not list 2,4,5-T as a carcinogen.
Medical Conditions Aggravated by Long-Term Exposure: None reported.
Chronic Effects: Chronic effects may occur from exposure to the contaminant TCDD (see *Genium* MSDS No. 906).
Other: Volunteers given 100 to 150 mg 2,4,5-T orally, excreted 80% in urine within 72 hr. Experimental reproductive and mutagenic effects have been reported (Sec. 11).

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Section 4 - First Aid Measures

Inhalation: Remove exposed person to fresh air and support breathing as needed.
Eye Contact: *Do not* allow victim to rub or keep eyes tightly shut. Gently lift eyelids and flush immediately and continuously with flooding amounts of water. Consult a physician or ophthalmologist if pain or irritation persist.
Skin Contact: *Quickly* remove contaminated clothing. Rinse away loose material with flooding amounts of water followed quickly by several soap and water washes. Wash exposed hair and nails. For reddened or blistered skin, consult a physician.
Ingestion: Never give anything by mouth to an unconscious or convulsing person. Contact a poison control center. Unless the poison control center advises otherwise, have the *conscious and alert* person drink 1 to 2 glasses of water, then induce vomiting. This is most effective if performed within 30 minutes of ingestion.
After first aid, get appropriate in-plant, paramedic, or community medical support.
Note to Physicians: Monitor respiratory status, electrolytes, renal and liver function, CBC, and cardiac status. Follow LDH, SGOT, and alkaline phosphatase to detect liver injury, and CPK to detect muscle damage. Blood plasma and urine measurements may be useful in determining exposure.

Section 5 - Fire-Fighting Measures

Genium

Flash Point: Noncombustible
Autoignition Temperature: Noncombustible
LEL: None reported.
UEL: None reported.
Extinguishing Media: Use agents suitable for surrounding fire.
Unusual Fire or Explosion Hazards: Container may explode in heat of fire (316.4 °F/158 °C). 2,4,5-T may be transported in molten form.
Hazardous Combustion Products: Carbon monoxide, hydrogen chloride, chlorine, and phosgene gas.
Fire-Fighting Instructions: Do not release runoff from fire control methods to sewers or waterways.
Fire-Fighting Equipment: Because fire may produce toxic thermal decomposition products, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in pressure-demand or positive-pressure mode. Structural firefighters' protective clothing *does not* protect against 2,4,5-T or its contaminant, TCDD.

Section 6 - Accidental Release Measures

Spill /Leak Procedures: Notify safety personnel, isolate and ventilate area, deny entry, and stay upwind. Cleanup personnel should protect against inhalation and skin/eye contact.
Small Spills: Carefully scoop up spills or vacuum (use appropriate filter). To avoid dust generation, *do not* sweep! If 2,4,5-T is in solution with oil or diesel fuel, take up with absorbent, noncombustible material and place in suitable container for later disposal.
Large Spills
Containment: Flush with water to containment area for later disposal. Do not release into sewers or waterways.
Cleanup: Thoroughly wash spill area with detergent to remove any residue.
Regulatory Requirements: Follow applicable OSHA regulations (29 CFR 1910.120).

Section 7 - Handling and Storage

Handling Precautions: Use appropriate PPE when handling 2,4,5-T.
Storage Requirements: Because the use of 2,4,5-T is no longer allowed, storage of this material should only be for purposes of awaiting disposal. Store in a cool, dry, well-ventilated area away from other agrochemicals or seeds. 2,4,5-T has a minimum shelf-life of 2 years.

Section 8 - Exposure Controls / Personal Protection

Engineering Controls: Enclose all processes where possible to prevent dispersion of 2,4,5-T dusts into work area.
Ventilation: Provide general or local exhaust ventilation systems to maintain airborne concentrations below OSHA PELs (Sec. 2). Local exhaust ventilation is preferred because it prevents contaminant dispersion into the work area by controlling it at its source.[103]
Administrative Controls: Consider preplacement and periodic medical exams of exposed workers with emphasis on the skin and liver. Routine measurements of blood plasma and urine may be helpful.
Respiratory Protection: Seek professional advice prior to respirator selection and use. Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, wear a MSHA/NIOSH-approved respirator. For ≤ 50 mg/m^3, use any dust and mist respirator. For ≤ 100 mg/m^3, use any dust and mist respirator except single-use and quarter-mask respirators. For ≤ 250 mg/m^3, use any supplied-air respirator operated in a continuous-flow mode; any air-purifying, full facepiece respirator with a high-efficiency particulate filter; any powered, air-purifying respirator with a dust and mist filter; or any SCBA with a full facepiece. Select respirator based on its suitability to provide adequate worker protection for given working conditions, level of airborne contamination, and presence of sufficient oxygen. For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), wear an SCBA. *Warning! Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.* If respirators are used, OSHA requires a written respiratory protection program that includes at least: medical certification, training, fit-testing, periodic environmental monitoring, maintenance, inspection, cleaning, and convenient, sanitary storage areas.

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Protective Clothing/Equipment: Wear chemically protective gloves, boots, aprons, and gauntlets to prevent prolonged or repeated skin contact. *Do not* wear leather clothing. If leather does become contaminated, dispose of rather than clean. Decontamination is highly ineffective for leather items because it concentrates 2,4,5-T. Wear protective eyeglasses or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133). Contact lenses are not eye protective devices. Appropriate eye protection must be worn instead of, or in conjunction with contact lenses.
Safety Stations: Make emergency eyewash stations, safety/quick-drench showers, and washing facilities available in work area.
Contaminated Equipment: Separate contaminated work clothes from street clothes. Launder before reuse. Remove 2,4,5-T from your shoes and clean personal protective equipment.
Comments: Never eat, drink, or smoke in work areas. Practice good personal hygiene after using 2,4,5-T, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

Section 9 - Physical and Chemical Properties

Physical State: Solid
Appearance and Odor: White to light tan, odorless crystals with a metallic taste.
Vapor Pressure: 0 mm Hg at 68 °F (20 °C)
Formula Weight: 255.49
Specific Gravity (H_2O=1, at 4 °C): 1.803 at 68 °F (20 °C)
Water Solubility: 0.028% at 77 °F (25 °C)
Henry's Law Constant: 3.44 x 10^{-8} atm m^3/mole
Other Solubilities: % 2,4,5-T as follows: 95% ethanol (54.8%), *n*-heptane (0.039 %), ethyl ether (23.4 %), methanol (49.6 %), toluene (0.73 %), xylene (0.61 %). Slightly soluble in petroleum ether.
Boiling Point: Decomposes
Melting Point: 303.8 to 307.8 °F (151 to 153 °C)
Octanol/Water Partition Coefficient: log Kow = 4

Section 10 - Stability and Reactivity

Stability: 2,4,5-Trichlorophenoxyacetic acid is stable at room temperature in closed containers under normal storage and handling conditions. Temperatures above 316 °F (158 °C) lead to instability (melting point).
Polymerization: Hazardous polymerization does not occur.
Chemical Incompatibilities: Although *pure* 2,4,5-T is noncorrosive itself, some oil-based mixtures may affect painted surfaces.
Conditions to Avoid: Exposure to excessive heat and generation of 2,4,5-T dusts.
Hazardous Decomposition Products: Thermal oxidative decomposition of 2,4,5-trichlorophenoxyacetic acid can produce carbon monoxide, chlorine, hydrogen chloride, and phosgene gas.

Section 11 - Toxicological Information

Toxicity Data:*

Acute Dermal Effects: Rat, skin, LD_{50}: 1535 mg/kg
Reproductive Effects:
Rat, oral: 6 mg/kg administered on the 8th day of pregnancy caused behavioral effects.
Rat, oral: 27600 µg/kg administered from the 10th to 15th day of pregnancy caused specific developmental abnormalities of the urogenital system and other developmental abnormalities.
Mutagenicity:
Salmon, sperm cell: 100 µmol/L caused mutation.
Acute Oral Effects:
Rat, oral, LD_{50}: 300 mg/kg
Mouse, oral, LD_{50}: 242 mg/kg
Dog, oral, LD_{50}: 100 mg/kg
Multiple Dose Toxicity Data:
Rat, oral: 196 mg/kg administered intermittently for 28 weeks caused fatty liver degeneration.
Tumorigenicity:
Mouse, oral: 3379 mg/kg administered continuously for 33 weeks produced kidney, ureter, bladder, and skin tumors.

* See NIOSH, *RTECS* (AJ8400000), for additional toxicity data.

Section 12 - Ecological Information

Ecotoxicity: Rainbow trout (*Salmo gairdneri*), LC_{50} = 0.98 mg/L/96 hr; bluegill (*Lepomis machrochirus*), LC_{50} = 0.5 mg/L/48 hr.
Environmental Transport: 2,4,5-T can be carried to the atmosphere during wind erosion of treated soils.
Environmental Degradation: In soil, 2,4,5-T is expected to biodegrade rapidly to form 2,4,5-trichlorophenol and 2,4,5-trichloroanisole. 2,4,5-T can persist in soil anywhere from 14 to 300 days depending on climate conditions and concentration of microorganisms in soil, but is not expected to exceed one year. However, the TCDD contained as a contaminant within 2,4,5-T may persist for longer periods (see *Genium* MSDS No. 906). In water, 2,4,5-T will be found in the dissociated form due to a pKa of 2.88. It is then subject to photochemical decomposition and biodegradation. The estimated half-life in surface water is 15 days during summer at 40° latitude. If humic substances are present at levels > 15 mg of organic carbon/L, humic-induced photoreactions may dominate the photodegradation process. 2,4,5-T can also be degraded by photocatalytic processes involving iron species and peroxides. The primary products of aquatic decomposition are 2,4,5-trichlorophenol and 2-hydroxy-4,5-dichlorophenoxyacetic acid. Oxidation, chemical hydrolysis, volatilization, and bioaccumulation are not expected to occur. The bioconcentration factor in static ecosystems is 23 to 25 in fish. In the air, 2,4,5-T can exist in vapor form as fine droplets or adsorbed to particulates. It can undergo direct photolysis due to ultraviolet absorption at > 290 nm or react with photochemically-produced hydroxyl radicals (est. vapor half-life = 1.12 days). Removal from air may also occur via washout due to precipitation.

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Soil Absorption/Mobility: Mobility varies depending on soil type. It is expected to be highly mobile in sandy soil, moderately mobile in clay and silt loams, and slightly mobile in muck due to adsorption to humic material.

Section 13 - Disposal Considerations

Disposal: 2,4,5-Tetrachlorophenoxyacetic acid is a good candidate for liquid injection, rotary kiln, and fluidized bed incineration. Sanitary landfill is not a recommended means of disposal because TCDD, the contaminant in 2,4,5-T is very persistent in soils. Although it is possible to degrade 2,4,5-T by acidification and chlorination, the end products are not clearly identified. As a result, no practical detoxification methods are currently available. Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.

Container Cleaning and Disposal: Triple rinse containers. Dispose of rinse water as above. If reuse is permitted by regulations, return to supplier. If reuse is not permitted, puncture container and ship to scrap metal facility.

Section 14 - Transport Information

DOT Transportation Data (49 CFR 172.101):

Shipping Name: Phenoxy pesticides, solid, toxic
Shipping Symbols: –
Hazard Class: 6.1
ID No.: UN2765
Packing Group: III
Label: Keep Away From Food
Special Provisions (172.102): –

Packaging Authorizations
a) Exceptions: 173.153
b) Non-bulk Packaging: 173.213
c) Bulk Packaging: 173.240

Quantity Limitations
a) Passenger, Aircraft, or Railcar: 100 kg
b) Cargo Aircraft Only: 200 kg

Vessel Stowage Requirements
a) Vessel Stowage: A
b) Other: 40

Section 15 - Regulatory Information

EPA Regulations:
Listed as a RCRA Hazardous Waste (40 CFR 261.33): U232 & F027
Listed as a CERCLA Hazardous Substance (40 CFR 302.4) per RCRA, Sec. 3001 & CWA, Sec. 311 (b)(4)
CERCLA Reportable Quantity (RQ), 1000 lb (454 kg)
SARA Toxic Chemical (40 CFR 372.65): Not listed
SARA EHS (Extremely Hazardous Substance) (40 CFR 355): Not listed
OSHA Regulations:
Listed as an Air Contaminant (29 CFR 1910.1000, Table Z-1, Z-1-A)

Section 16 - Other Information

References: 73, 103, 124, 136, 189, 197, 201, 203

Prepared By ..... M Gannon, BA
Industrial Hygiene Review ..... S Gilson, CIH
Medical Review ..... W Boucher, MD

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Dieldrin **MSDS No. 940**

Date of Preparation: 12/94

Section 1 - Chemical Product and Company Identification 45

Product/Chemical Name: Dieldrin
Chemical Formula: $C_{12}H_8Cl_6O$
CAS No.: 60-57-1
Synonyms: Alvit; Dieldrite; HEOD; 1,2,3,4,10,10-hexachloro-6,7-epoxy,1,4,4a,5,6,7,8,8a, octahydro-endo-1,4-exo-5,8-dimethanonaphthalene; insecticide no. 497; Octalox; Quintox
Derivation: By oxidation of aldrin with peracids. Dieldrin also occurs in the environment as a *degradation* product of aldrin.
General Use: Used widely as an insecticide until 1974 when its use agriculturally was banned. Use as a moth-proofing agent for woolen goods and for termite control continued for several years, but as of 1992, it is no longer produced or used in the US. Still used in some countries for the control of malaria mosquitoes and other related vector-borne diseases.
Vendors: Consult the latest *Chemical Week Buyers' Guide.* (73)

Section 2 - Composition / Information on Ingredients

Dieldrin, ca 85%wt + ca 15%wt other related active ingredients (technical grade).

OSHA PEL
8-hr TWA: 0.25 mg/m^3 (skin)

ACGIH TLVs
TWA: 0.25 mg/m^3 (skin)

NIOSH REL
10-hr TWA: 0.25 mg/m^3 (skin)
LOQ:* 0.15 mg/m^3

IDLH Level
450 mg/m^3

DFG (Germany) MAK
TWA: 0.25 mg/m^3 (skin)
Category III: Substances with systemic effects
Onset of Effect: > 2 hr
Half-life: > shift length (strongly cumulative)

Peak Exposure Limit: 2.5 mg/m^3, 30 min. average value, 1/shift.

* LOQ = Limit of Quantitation

Section 3 - Hazards Identification

☆☆☆☆☆ Emergency Overview ☆☆☆☆☆

Dieldrin exists as an odorless, white, crystalline solid (pure) or a light tan to brown powder (technical grade). It is a central nervous system stimulant that can cause symptoms ranging from dizziness to convulsions. It is readily absorbed through the skin. Although no longer produced or used in the US, dieldrin has been very persistent in the environment and poses a health hazard through exposure to contaminated soil, water, and vegetation. Exposure to dieldrin can occur at hazardous waste disposal sites or contaminated manufacturing areas, where the exposure is from surface contamination or contaminated soils.

Wilson Risk Scale
R 1
I 3
S 1*
K 0
*Skin absorption

HMIS
H 3†
F 0
R 0
† Chronic effects
PPE‡
‡Sec. 8

Potential Health Effects

Primary Entry Routes: Inhalation, skin contact/absorption.
Target Organs: Central nervous system and possibly, the liver and kidneys (by analogy to animals).
Acute Effects
Inhalation: Symptoms include hyperirritability, nausea and vomiting, headache, fatigue, dizziness, blurred vision, tremors, tonic/clonic convulsions, coma, and respiratory failure. It is possible that exposure may cause damage to the liver and kidneys, but thus far, this can only be confirmed in animal studies.
Eye: Dieldrin may be absorbed into the body by direct eye contact. Some local irritation may occur depending on what vehicle (solvent, oil) it is dissolved in.
Skin: Dieldrin is readily absorbed through the skin, producing greater toxicity than would occur from exposure via inhalation to the same concentration.
Ingestion: Effects similar to those caused via inhalation.
Carcinogenicity: NTP and OSHA do not list dieldrin as a carcinogen. IARC rates dieldrin as Group 3 (unclassifiable as to carcinogenicity in humans). Listed as a NIOSH Class X (carcinogen defined without further categorization) and EPA Class 2B (sufficient animal evidence; insufficient human evidence) carcinogen.
Medical Conditions Aggravated by Long-Term Exposure: Central nervous system disorders and possibly, liver and kidney disorders.
Chronic Effects: Repeated exposure may result in symptoms including fainting, muscle spasms, tremors, and weight loss.
Other: Dieldrin is stored unchanged primarily in the fatty tissue. It may cause teratogenic effects based on animal data.

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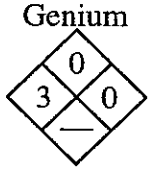
Section 4 - First Aid Measures

Inhalation: Remove exposed person to fresh air, monitor for respiratory distress, and support breathing as needed.
Eye Contact: *Do not* allow victim to rub or keep eyes tightly shut. Gently lift eyelids and flush immediately and continuously with flooding amounts of water for at least 15 min. Consult a physician or ophthalmologist if pain or irritation persist.
Skin Contact: *Quickly* remove contaminated clothing. Rinse with flooding amounts of water. Wash thoroughly with soap, followed by a wash with alcohol and a second wash with soap. For reddened or blistered skin, consult a physician.
Ingestion: Never give anything by mouth to an unconscious or convulsing person. Contact a poison control center. Unless the poison control center advises otherwise, *do not* induce vomiting because of the potential for this material to cause seizures. Gastric lavage performed by a physician may be necessary.
After first aid, get appropriate in-plant, paramedic, or community medical support.
Note to Physicians: Gastric lavage may be indicated in recent, substantial ingestions. Activated charcoal and sodium sulfate may also be beneficial. Urinalysis of halogenated compounds is a good indicator of exposure.

Section 5 - Fire-Fighting Measures

Genium



Flash Point: Noncombustible.
Autoignition Temperature: Noncombustible.
LEL: None reported.
UEL: None reported.
Extinguishing Media: Use agents suitable for surrounding fire.
Unusual Fire or Explosion Hazards: Dieldrin may become molten in heat of fire.
Hazardous Combustion Products: Hydrogen chloride and other chloride gases.
Fire-Fighting Instructions: Do not release runoff from fire control methods to sewers or waterways.
Fire-Fighting Equipment: Because fire may produce toxic thermal decomposition products, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in pressure-demand or positive-pressure mode. Structural firefighters' protective clothing is *not* effective against dieldrin. Use protective clothing specifically recommended by the manufacturer.

Section 6 - Accidental Release Measures

Spill/Leak Procedures: Notify safety personnel. Cleanup personnel should protect against inhalation and skin/eye contact. Carefully scoop up or vacuum (with appropriate filter) and place in suitable containers. *Do not* sweep! If dieldrin is in solution, take up with earth, sand, vermiculite, or other absorbent, noncombustible material.
Containment: For large spills, flush with water to containment area for later disposal. Do not release into sewers or waterways.
Regulatory Requirements: Follow applicable OSHA regulations (29 CFR 1910.120).

Section 7 - Handling and Storage

Handling Precautions: Avoid dispersing dieldrin into the air. *Do not* wear leather clothing, gloves, or shoes.
Storage Requirements: Store in a cool, dry, well-ventilated area away from incompatibles.
***Note*:** Because the manufacture and use of dieldrin is now banned in the US, storage should only be for the purpose of awaiting disposal.

Section 8 - Exposure Controls / Personal Protection

Engineering Controls: Enclose all processes where possible to prevent dust dispersion into work area.
Ventilation: Provide general or local exhaust ventilation systems to maintain airborne concentrations below OSHA PEL (Sec. 2). Local exhaust ventilation is preferred because it prevents contaminant dispersion into the work area by controlling it at its source.[103]
Administrative Controls: Consider preplacement and periodic medical exams of workers exposed to dieldrin with emphasis on the central nervous system, liver, and kidneys.
Respiratory Protection: Seek professional advice prior to respirator selection and use. Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, wear a MSHA/NIOSH-approved respirator. For any detectable concentration, use a SCBA or supplied-air respirator (with auxiliary SCBA) with a full facepiece and operated in pressure-demand or other positive-pressure mode. For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), wear an SCBA. *Warning! Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.* If respirators are used, OSHA requires a written respiratory protection program that includes at least: medical certification, training, fit-testing, periodic environmental monitoring, maintenance, inspection, cleaning, and convenient, sanitary storage areas.
Protective Clothing/Equipment: Wear chemically protective gloves, boots, aprons, and gauntlets to prevent prolonged or repeated skin contact. *Do not* wear *leather* clothing, gloves, or shoes! Wear protective eyeglasses or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133). Contact lenses are not eye protective devices. Appropriate eye protection must be worn instead of, or in conjunction with contact lenses.
Safety Stations: Make emergency eyewash stations, safety/quick-drench showers, and washing facilities available in work area.
Contaminated Equipment: Separate contaminated work clothes from street clothes. Launder before reuse. Remove dieldrin from your shoes and clean personal protective equipment. *Discard* any contaminated leather clothing, gloves, or shoes.
Comments: Never eat, drink, or smoke in work areas. Practice good personal hygiene after exposure to dieldrin, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

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Section 9 - Physical and Chemical Properties

Physical State: Solid
Appearance and Odor: Odorless, white, crystals (pure); light tan to brown powder with a distinct chemical odor (technical grade).
Odor Threshold: (technical grade): 0.041 ppm
Vapor Pressure: 1.8 x 10^{-7} mm Hg at 77 °F (25 °C)
Formula Weight: 380.93
Density (H_2O=1, at 4 °C): 1.62 g/m^3 at 68 °F (20 °C)
Water Solubility: 0.186 mg/l

Other Solubilities: Slightly soluble in mineral oil and aliphatic hydrocarbons. Moderately soluble in aromatic hydrocarbons, halogenated solvents, esters, and ketones. Soluble in the following (grams of dieldrin/liter of solvent): acetone (220 g), ethanol (40 g), benzene (400 g), carbon tetrachloride (380 g), toluene (410 g), dichloromethane (480 g), methanol (10 g). 48g dieldrin/100 mL ethylene dichloride.
Boiling Point: Decomposes
Melting Point: 348.8 °F/176 °C (pure) ; ≥ 203 °F/95 °C (technical grade)

Section 10 - Stability and Reactivity

Stability: Dieldrin is stable at room temperature in closed containers under normal storage and handling conditions. Degrades in sunlight to form photodieldrin.
Polymerization: Hazardous polymerization does not occur.
Chemical Incompatibilities: Strong oxidizers, active metals such as sodium, mineral acids, acid catalysts, and phenols.
Conditions to Avoid: Exposure to excessive temperatures and incompatibles.
Hazardous Decomposition Products: Include hydrogen chloride and other chloride gases.

Section 11- Toxicological Information

Toxicity Data:*

Acute Inhalation Effects:
Rat, inhalation, LC_{50}: 13 mg/m^3/4 hr
Cat, inhalation, LC_{50}: 80 mg/m^3/4 hr caused excitement, somnolence, and convulsions or effect on seizure threshold.
Teratogenicity:
Mouse, oral, 15 mg/kg given on the 9th day of pregnancy caused specific developmental abnormalities (craniofacial, including nose and tongue).
Mouse, oral, 30.6 mg/kg given from 6 to 14 days of pregnancy caused specific developmental abnormalities of the central nervous system, ear, and eye.
Acute Dermal Effects:
Rat, skin, LD_{50}: 56 mg/kg

Acute Oral Effects:
Man, oral, LD_{Lo}: 65 mg/kg
Cat, oral, LD_{Lo}: 500 mg/kg caused pulmonary edema or fatty liver degeneration.
Rat, oral, LD_{50}: 38.3 mg/kg
Tumorigenicity:
Mouse, oral: 546 mg/kg administered continuously for 65 weeks produced liver tumors.
Mutagenicity:
Human, lymphocyte: 100 mg/L caused DNA inhibition.
Human, fibroblast: 1 μmol/L caused unscheduled DNA synthesis.

* See NIOSH, *RTECS* (IO1750000), for additional toxicity data.

Section 12 - Ecological Information

Ecotoxicity: Tadpoles, LC_{50} = 100 μg/l/96 hr; cutthroat trout, LC_{50} = 6 μg/l/96 hr.
Environmental Degradation: Dieldrin is very persistent in the environment. In soil, dieldrin will persist for > 7 yr. Its low water solubility and strong absorption to soil makes leaching unlikely. Some may volatilize from soil or be carried into the air via dust particles. In water, it will photorearrange to photodieldrin (half-life = 4 months). Biodegradation and hydrolysis do not occur. Bioconcentration will occur (BCF of 3 to 6000 in fish). In the air, dieldrin will photodegrade (rate not reported).

Section 13 - Disposal Considerations

Disposal: Dieldrin is a good candidate for rotary kiln incineration at 1508 to 2912 °F (820 to 1600 °C). See *Management of Hazardous Waste Leachate*, USEPA Contract N. 68-03-2766 (1982) for further discussion on disposal methods. Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.

Section 14 - Transport Information

DOT Transportation Data (49 CFR 172.101):

Shipping Name: Dieldrin
Shipping Symbols: D
Hazard Class: 6.1
ID No.: NA2761
Packing Group: II
Label: Poison
Special Provisions (172.102): –

Packaging Authorizations
a) Exceptions: None
b) Non-bulk Packaging: 173.212
c) Bulk Packaging: 173.242

Quantity Limitations
a) Passenger, Aircraft, or Railcar: 0.5 kg
b) Cargo Aircraft Only: 5 kg

Vessel Stowage Requirements
a) Vessel Stowage: A
b) Other: 40

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Section 15 - Regulatory Information

EPA Regulations:
Listed as a RCRA Hazardous Waste (40 CFR 261.33): P037
CERCLA Hazardous Substance (40 CFR 302.4) listed per RCRA, Sec. 3001; CWA, Sec. 311 (b)(4); and CWA, Sec. 307(a).
CERCLA Reportable Quantity (RQ), 1 lb (0.454 kg)
SARA Toxic Chemical (40 CFR 372.65): Not listed
SARA EHS (Extremely Hazardous Substance) (40 CFR 355): Not listed
OSHA Regulations:
Listed as an Air Contaminant (29 CFR 1910.1000, Table Z-1)

Section 16 - Other Information

References: 73, 103, 124, 133, 136, 139, 176, 189, 192, 197, 201

Prepared By ..... M Gannon, BA
Industrial Hygiene Review ..... DJ Wilson, CIH
Medical Review ..... T Thoburn, MD, MPH

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Material Safety Data Sheet Collection

Heptachlor **MSDS No. 954**

Date of Preparation: 4/95

Section 1 - Chemical Product and Company Identification 46

Product/Chemical Name: Heptachlor
Chemical Formula: $C_{10}H_5Cl_7$
CAS Number: 76-44-8
Synonyms: Aahepta; Agroceres; Basaklor; 3-chlorochlordene; α-dicyclopentadiene,3,4,5,6,7,8,8a-heptachloro-; E 3314; Gold Crest H-60, GPKH; H-34; Hepta; Heptachlorane; Heptagran; Heptagranox; Heptamul; Heptasol; Heptox; 4,7-methano-1H-indene; 4,7-methanoindene,1,4,5,6,7,8,8-heptachloro-3a,4,7,7a-tetrahydro-; NCI-C00180; Rhodiachlor; Soleptax; Termide; Velsicol 104.
Derivation: By chlorination of the adduct of hexachlorocyclopentadiene and cyclopentadiene using sulfonyl chloride in the presence of benzoyl peroxide or chlorine in the dark and presence of Fuller's earth.
General Use: Formerly used as an insecticide for seed treatment and in the control of certain soil-inhabiting insects that attack corn and other field crops. Its only permitted use in the US since 1983 is for subsurface soil treatments for termites and the dipping of nonfood plants.
Vendors: Consult the latest *Chemical Week Buyers' Guide.* (73)

Section 2 - Composition / Information on Ingredients

Heptachlor, ca 72 %wt; trace Impurities: 28% *trans*-chlordane, *cis*-chlordane, nonachlor.

OSHA PELs
8-hr TWA: 0.5 mg/m^3, *Skin*

ACGIH TLVs
TWA: 0.05 mg/m^3, *Skin*

NIOSH REL
10-hr TWA: 0.5 mg/m^3, *Skin*

IDLH Level
35 mg/m^3

DFG (Germany) MAK
TWA: 0.5 mg/m^3, total dust
Danger of cutaneous absorption
Category III: Substances with systemic effects, onset of effect > 2 hr, half-life > shift length (strongly cumulative)

Peak Exposure Limit:
5 mg/m^3, 30 min, average value, 1 per shift

Section 3 - Hazards Identification

☆☆☆☆☆ Emergency Overview ☆☆☆☆☆

White to light tan waxy solid with a camphor-like odor. Heptachlor is a convulsant and at high doses it may cause kidney or liver damage. Handle with extreme caution! It is a possible carcinogen.

Wilson Risk Scale
R 1
I 4
S 4*
K 1
* Skin absorption

HMIS
H 3*
F 0
R 0
* Chronic effects
PPE†
†Sec. 8

Potential Health Effects

Primary Entry Routes: Inhalation, skin contact/absorption, eye contact, and ingestion.
Target Organs: Central nervous system (CNS), liver.
Acute Effects
Inhalation: Apprehension, excitability, paresthesias ("pins and needles" sensation), dizziness, headache, disorientation, and tremor progressing to stupor, coma, convulsions, respiratory collapse and death in severe cases. Exposure to high concentrations may cause kidney or liver damage.
Eye: Irritation.
Skin: Irritation. Systemic effects, as seen with inhalation or ingestion, may also occur with skin contamination. The dermal toxicity of heptachlor to man is estimated to be 46 g for a single exposure or 1.2 g/day for multiple exposures.
Ingestion: Apprehension, agitation, nausea, vomiting, diarrhea, abdominal pain, hypotension (low blood pressure) and CNS depression. Convulsions may occur at higher doses and may be preceded by symptoms of ataxia (loss of muscular coordination), muscle spasms, and fasciculations (twitching). Kidney or liver damage may also occur with ingestion of large doses. Intoxication from acute oral exposure generally begins within 45 min to several hr.
Carcinogenicity: NTP and OSHA do not list heptachlor as a carcinogen. The IARC classifies heptachlor as IARC-2B (possibly carcinogenic to humans: limited evidence in humans in the absence of sufficient evidence in experimental animals). NIOSH classifies heptachlor as NIOSH-X (carcinogen defined with no further categorization). The EPA classifies heptachlor as EPA-B2 (sufficient evidence from animal studies; inadequate evidence or no data from epidemiologic studies). The ACGIH classifies heptachlor as TLV-A3 (animal carcinogen). The DFG classifies heptachlor as MAK-B (justifiably suspected of having carcinogenic potential).
Medical Conditions Aggravated by Long-Term Exposure: Kidney, liver, and lung disease and convulsive disorders.

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Chronic Effects: Dermatitis, headaches, personality changes (being irritable, moody), poor memory and concentration, peripheral paresthesias, tremors, convulsions, and liver and kidney damage.

Other: Blood dyscrasias (an imbalance of components of the blood), anemia, and leukemia have been associated with organochlorine exposure in general. Heptachlor has little if any mutagenic activity, but there is evidence that heptachlor may have an effect on cell to cell communication which is a property of promoting agents. Occasional reports have associated peripheral neuropathy (an abnormal or usually degenerative state involving the nerves of the extremities) with exposure to organochlorines in general.

Section 4 - First Aid Measures

Inhalation: Remove exposed person to fresh air, monitor for respiratory distress, and support breathing as needed.

Eye Contact: *Do not* allow victim to rub or keep eyes tightly shut. Gently lift eyelids and flush immediately and continuously with flooding amounts of water for at least 15 min. Consult a physician or ophthalmologist immediately if pain or irritation persist.

Skin Contact: *Quickly* remove contaminated clothing. Rinse particles off and thoroughly wash exposed area (including hair and nails) with soap and water, 3 times. Do an initial soap washing followed by an alcohol wash, and then followed by a final soap washing. For reddened or blistered skin, consult a physician.

Ingestion: Never give anything by mouth to an unconscious or convulsing person. Contact a poison control center. Unless the poison control center advises otherwise, *do not* induce vomiting due to potential CNS depression or seizures.

After first aid, get appropriate in-plant, paramedic, or community medical support.

Note to Physicians: For patients with significant exposure, monitor CBC, urinalysis, and liver and kidney function tests. For cases of ingestion, consider gastric lavage and use of activated charcoal and sodium sulfate. To manage seizures, consider diazepam as an anticonvulsant. *Do not* use epinephrine, other adrenergic amines, or atropine as they may cause myocardial irritation and ventricular arrhythmias.

Special Precautions/Procedures: Emergency personnel should protect against contamination when aiding exposure victims. *Do not* wear leather items. *Do not* use oils as cathartics or dermal cleansing agents as they increase absorption of heptachlor.

Section 5 - Fire-Fighting Measures

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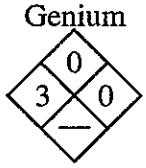

Flash Point: Noncombustible, but may be dissolved in a flammable liquid.

Autoignition Temperature: None reported.

LEL: None reported.

UEL: None reported.

Extinguishing Media: Use extinguishing media appropriate to the surrounding fire.

Unusual Fire or Explosion Hazards: Container may explode in the heat of fire.

Hazardous Combustion Products: Hydrogen chloride, carbonyl chloride, and carbon monoxide.

Fire-Fighting Instructions: Do not release runoff from fire control methods to sewers or waterways. Remove and isolate contaminated clothing at the site.

Fire-Fighting Equipment: Because fire may produce toxic thermal decomposition products, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in pressure-demand or positive-pressure mode. Structural firefighters' protective clothing is *not* effective for these materials. Wear protective clothing specifically recommended by the manufacturer or shipper. It may provide little or no thermal protection.

Section 6 - Accidental Release Measures

Spill /Leak Procedures: Notify safety personnel, evacuate all unnecessary personnel, shut off heat and ignition sources, and isolate and ventilate area. Cleanup personnel should protect against inhalation and skin or eye contact.

Small Spills: Carefully scoop up spilled material and place into appropriate containers for disposal. Absorb liquid containing heptachlor in vermiculite, dry sand, earth, or a similar material and place into appropriate containers for disposal.

Large Spills

Containment: For large spills, dike far ahead of liquid spill for later disposal. *Do not* release into sewers or waterways.

Cleanup: Wet mop or use vacuum cleaner equipped with a high-efficiency particulate filter on exhaust. *Do not* sweep!

Regulatory Requirements: Follow applicable OSHA regulations (29 CFR 1910.120).

Section 7 - Handling and Storage

Handling Precautions: Avoid any exposure to heptachlor. Use only with adequate ventilation and wear personal protective clothing and equipment. Practice good personal hygiene and housekeeping procedures.

Storage Requirements: Store in tightly closed containers in a cool, dark, well-ventilated area away from heat and ignition sources and incompatibles (Sec. 10). Outdoor or detached storage is preferred.

Section 8 - Exposure Controls / Personal Protection

Engineering Controls: Enclose all operations to prevent dust dispersion into the work area.

Ventilation: Provide general or local exhaust ventilation systems to maintain airborne concentrations below OSHA PELs (Sec. 2). Local exhaust ventilation is preferred because it prevents contaminant dispersion into the work area by controlling it at its source.[103]

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Administrative Controls: Consider preplacement and periodic medical exams with emphasis on the eyes, nervous system, liver, and kidneys.

Respiratory Protection: Seek professional advice prior to respirator selection and use. Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, wear a MSHA/NIOSH-approved respirator. Select respirator based on its suitability to provide adequate worker protection for given working conditions, level of airborne contamination, and presence of sufficient oxygen. At any detectable concentration, wear any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode; or any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in pressure-demand or other positive-pressure mode. For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), wear an SCBA. *Warning! Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.* If respirators are used, OSHA requires a written respiratory protection program that includes at least: medical certification, training, fit-testing, periodic environmental monitoring, maintenance, inspection, cleaning, and convenient, sanitary storage areas.

Protective Clothing/Equipment: Wear chemically protective gloves, boots, aprons, and gauntlets to prevent prolonged or repeated skin contact. *Do not* wear leather items as leather concentrates chlorinated pesticides. Appropriately discard contaminated leather items; consider incineration. Wear protective eyeglasses or chemical safety, dust-proof goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133). Contact lenses are not eye protective devices. Appropriate eye protection must be worn instead of, or in conjunction with contact lenses.

Safety Stations: Make emergency eyewash stations, safety/quick-drench showers, and washing facilities available in work area.

Contaminated Equipment: Separate contaminated work clothes from street clothes. Launder before reuse. Remove heptachlor from your shoes and clean personal protective equipment.

Comments: Never eat, drink, or smoke in work areas. Practice good personal hygiene after using heptachlor, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

Section 9 - Physical and Chemical Properties

Physical State: Solid

Appearance and Odor: White to light tan color, waxy; camphor-like odor.

Odor Threshold: 0.02 ppm

Vapor Pressure: 3 x 10^{-4} mm Hg at 77 °F (25 °C)

Formula Weight: 373.35

Density (H_2O=1, at 4 °C): 1.65-1.67 g/mL at 77 °F (25 °C)

Water Solubility: 0.056 mg/L

Other Solubilities: Hexane, petroleum distillates, slightly soluble in xylene; alcohols, ketones; (g/100 mL solvent at 27 °C): acetone: 75; benzene: 106; carbon tetrachloride: 112; cyclohexanone: 119.

Boiling Point: 293 °F (145 °C) at 1.5 mm Hg

Melting Point: 203-205 °F (95-96 °C)

Corrosivity: Corrosive to metals.

Henry's Law Constant: 2.62 x 10^{-3} atm m^3/mol (estimated)

Octanol/Water Partition Coefficient: log Kow = 3.87-5.44 (estimated)

Section 10 - Stability and Reactivity

Stability: Heptachlor is stable at room temperature in closed containers under normal storage and handling conditions. It is oxidized biologically to heptachlor epoxide.

Polymerization: Hazardous polymerization does not occur.

Chemical Incompatibilities: Alkali metals; it can react with iron and rust to form hydrogen chloride gas. It is oxidized by chromic trioxide in acetic acid to give heptachlor epoxide. Heptachlor is corrosive to metals.

Conditions to Avoid: Avoid heat and ignition sources and incompatibles.

Hazardous Decomposition Products: Thermal oxidative decomposition of heptachlor can produce hydrogen chloride, carbonyl chloride, and carbon monoxide.

Section 11 - Toxicological Information

Toxicity Data:*

Acute Effects:

Rat, oral, LD_{50}: 40 mg/kg

Rat, skin, LD_{50}: 119 mg/kg

Rabbit, skin, LD_{50}: >2 g/kg

Multiple Dose Toxicity Data:

Mammal, oral: 2800 mg/kg/28 days/continuous; toxic effects include changes in kidney, adrenal, and spleen weight.

Tumorigenicity:

Mouse, oral: 403 mg/kg/80 weeks/continuous caused liver tumors.

Mutagenicity:

Human fibroblast: 100 µmol/L caused unscheduled DNA synthesis.

* See NIOSH, *RTECS* (PC0700000), for additional toxicity data.

Section 12 - Ecological Information

Ecotoxicity: *Simocephalus* (daphnids), EC_{50}: 47 µg/L/48 hr at 15 °C (95% confidence limit 32-68 µg/L); *Lepomis macrochirus* (bluegill), LC_{50}: 13 µg/L/96 hr at 63 °F (17 °C) (95% confidence limit 9-19 µg/L); ring-necked pheasant, LC_{50}: 224 ppm in 5 day diet (95% confidence limit 191-265 ppm), 8 days old.

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Environmental Transport: With bioconcentration factors on the order of 1 x 10^{+4} for several aquatic organisms, heptachlor exhibits a tendency for bioaccumulation.

Environmental Fate: Heptachlor will volatilize from soil surfaces, especially in moist soils. Beyond the surface, volatilization will be slower. If released to water, heptachlor will volatilize and hydrolyze to 1-hydroxychlordene (half-life of about 1 day). Adsorption to sediments may occur. Direct and photosensitized photolysis may occur, but are not expected to occur at a rate comparable to that of hydrolysis. In air, vapor phase heptachlor will react with photochemically-generated hydroxyl radicals with an estimated half-life of 36 min. Direct photolysis may also occur.

Environmental Degradation: Biodegradation may occur, but it is expected to be slow compared to hydrolysis. In soil, heptachlor will degrade to 1-hydroxychlordene, heptachlor epoxide and an unidentified metabolite less hydrophilic than heptachlor epoxide.

Soil Absorption/Mobility: Heptachlor is expected to adsorb strongly to soil and therefore, resist leaching to ground water. In moist soils, hydrolysis is expected to be significant. The half-life of heptachlor in soil was calculated to range from 0.4 to 0.8 yr. The mean disappearance rates ranged from 5.25-79.5%/yr depending upon the soil type and application mode. The highest rate was observed in sandy soil after an application of a granule formulation. Soil incorporation also led to rapid disappearance rates in all soil types.

Section 13 - Disposal Considerations

Disposal: Heptachlor is a potential candidate for rotary kiln incineration. Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.

Container Cleaning and Disposal: Triple rinse containers and dispose of wastewater accordingly.

Section 14 - Transport Information

DOT Transportation Data (49 CFR 172.101):

Shipping Name: Organochlorine pesticides, solid, toxic, n.o.s.
Shipping Symbols: —
Hazard Class: 6.1
ID No.: UN2761
Packing Group: I; II
Label: Poison
Special Provisions (172.102): —
* Packing Group I
† Packing Group II

Packaging Authorizations
a) Exceptions: None*†
b) Non-bulk Packaging: 173.211,* .212†
c) Bulk Packaging: 173.242*†

Quantity Limitations
a) Passenger, Aircraft, or Railcar: 5 kg;*25 kg†
b) Cargo Aircraft Only: 50 kg;*100 kg†

Vessel Stowage Requirements
a) Vessel Stowage: A*†
b) Other: 40*†

Section 15 - Regulatory Information

EPA Regulations:
Listed as a RCRA Hazardous Waste (40 CFR 261.33): Hazardous Waste No. P059
Listed as a CERCLA Hazardous Substance (40 CFR 302.4) specific per RCRA, Sec. 3001; CWA, Sec. 311 (b)(4); CWA, Sec. 307(a)
CERCLA Reportable Quantity (RQ), 1 lb (0.454 kg)
Listed as a SARA Toxic Chemical (40 CFR 372.65)
SARA EHS (Extremely Hazardous Substance) (40 CFR 355): Not listed

OSHA Regulations:
Listed as an Air Contaminant (29 CFR 1910.1000, Table Z-1)

Section 16 - Other Information

References: 73, 100, 101, 103, 124, 136, 167, 168, 176, 189, 190, 197, 201, 202

Prepared By ..... MJ Wurth, BS
Industrial Hygiene Review ..... PA Roy, MPH, CIH
Medical Review ..... T Thoburn, MD, MPH

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Material Safety Data Sheet Collection

Pentachlorophenol **MSDS No. 517**

Issue Date: 5/99

Section 1 - Chemical Product and Company Identification 52

Product/Chemical Name: Pentachlorophenol **Chemical Formula:** C_6HCl_5O; C_6Cl_5OH **CAS Number:** 87-86-5

Synonyms: Acutox; Chem-Penta; Chem-Tol; Chlon; Chlorophen; Cryptogil Oil; Dow Pentachlorophenol DP-2 Antimicrobial; Dowicide 6; Dowicide 7 Antimicrobial; Dowicide EC-7; Dura Treet II; Durotox; EP 30; Forpen-50 Wood Preservative; Fungifen; Grundier Arbezol; 1-hydroxypentachlorobenzene; Lauxtol A; Liroprem; Ontrack WE Herbicide; Ortho Triox Liquid Vegetation Killer; Osmose Wood Preserving Compound; PCP; Penchlorol; Penta; Penta Concentrate; Penta Ready; Penta WR; pentachlorophenate; 2,3,4,5,6-pentachlorophenol; pentachlorophenol, DP-2; Pentacon; Penta-Kil; Pentasol; Penwar; Peratox; Permacide; Permagard; Permasan; Permatox DP-2; Permite; Prevenol; Priltox; Santobrite; Santophen 20; Term-i-trol; Thompson's Wood Fix; Watershed Wood Preservative; Weed and Brush Killer; Weedone; Witophen P; Woodtreat A

Derivation: Produced by chlorinating phenol.

General Use: Used as an insecticide for termite control; as a pre-harvest defoliant; general herbicide; molluscide; fungicide; bactericide; antimildew agent; wood preservative; in the synthesis of pentachlorophene esters; in cooling towers of electric plants; as additives to adhesives based on starch and vegetable and animal protein; in shingles, roof tiles, brick walls, concrete blocks, insulation, pipe sealant compounds, photographic solutions, and textiles; and in drilling mud in the petroleum industry.

Vendors: Consult the latest *Chemical Week Buyers' Guide.* (73)

Section 2 - Composition / Information on Ingredients

Trace Impurities: chlorodibenzodioxins, chlorodibenzofurans (commercial); polychlorophenols, chlorodibenzodioxins, chlorodibenzofurans, polychlorobenzenes, hydroxychlorodiphenyl ethers, 2-bromo-3,4,5,6-tetrachlorophenol (technical grade)

OSHA PEL
8-hr TWA: 0.5 mg/m^3, *Skin*

NIOSH REL
10-hr TWA: 0.5 mg/m^3, *Skin*

DFG (Germany) MAK
Danger of cutaneous absorption

ACGIH TLV
*TWA: 0.5 mg/m^3, *Skin*

IDLH Level
2.5 mg/m^3

*Substances for which there are also ACGIH Biological Exposure Indices (BEIs™).

Section 3 - Hazards Identification

ANSI Signal Word: Danger!

☆☆☆☆☆ Emergency Overview ☆☆☆☆☆

Pentachlorophenol is a white or dark gray (technical grade) crystalline solid with a phenolic odor. It is highly toxic by ingestion or skin absorption and toxic by inhalation. Severely irritating to skin, eyes, and respiratory system. Also causes: upset stomach, high fever, increased metabolic rate, heart failure. Animal data suggest that pentachlorophenol may be a human carcinogen. Mutation data reported.

Wilson Risk Scale
R 1
I 3
S 3*
K 0
*Skin absorption

HMIS
H 3*
F 0
R 0
PPE†
*Chronic effects
†Sec. 8

Potential Health Effects

Primary Entry Routes: Inhalation, skin and/or eye contact, skin absorption **Target Organs:** Eyes, skin, liver, kidneys, and respiratory, central nervous (CNS), and cardiovascular systems **Acute Effects**: **Inhalation:** Causes irritation, cough, sneezing, rapid breathing; and systemic effects. **Eye:** Causes severe irritation or burns, pupil dilation, corneal opacity and numbness, and possibly permanent visual change or loss. **Skin:** Causes severe irritation or burns, dermatitis and systemic effects including upset stomach, weakness, twitching, rapid breathing, polyuria (frequent urination), followed by oliguria (little urination), metabolic acidosis, anemia, hemolysis, high fever, profuse sweating, thirst, increased basal metabolic rate, rapid heart beat, seizures, collapse, heart failure, coma, cerebral edema (brain swelling), and death. Significant exposures may cause permanent damage including impaired autonomic nervous function and circulation. **Ingestion:** Causes gastrointestinal tract irritation, loss of hunger, and systemic effects. **Carcinogenicity:** NTP and OSHA do not list pentachlorophenol as a carcinogen. IARC lists it as 2B (Possibly Carcinogenic to Humans); EPA as B2 (Probable Human Carcinogen, Sufficient Evidence From Animal Studies); DFG (Germany) MAK as A2 (Unmistakably carcinogenic in animal experimentation only); and TLV as A3 (Confirmed Animal Carcinogen with Unknown Relevance to Humans). **Medical Conditions Aggravated by Long-Term Exposure:** Individuals with kidney, liver, or metabolic disorders may be at a higher risk from exposure to pentachlorophenol. *Note: Pentachlorophenol may cross the placenta and affect an unborn child.* **Chronic Effects:** Chronic exposure to pentachlorophenol may cause dermatitis, chloracne, conjunctivitis, bronchitis, damage to the cardiovascular and immune systems, anorexia (appetite loss),

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anemia, weight loss, bruising, weakness, fever, sweating, dizziness, headache, anxiety, difficult breathing, kidney and liver damage, and possibly cancer.

Section 4 - First Aid Measures

Inhalation: Remove exposed person to fresh air and support breathing as needed. **Eye Contact:** *Do not* allow victim to rub or keep eyes tightly shut. Gently lift eyelids and flush immediately and continuously with flooding amounts of water for at least 15 min. Consult a physician or ophthalmologist if pain or irritation persist. **Skin Contact:** *Quickly* remove contaminated clothing and wash exposed area with soap and water, repeatedly. Get medical attention immediately. **Ingestion:** Never give anything by mouth to an unconscious or convulsing person. Contact a poison control center. *Do not* induce vomiting due to risk of CNS depression and seizures. ***After first aid, get appropriate in-plant, paramedic, or community medical support.*** **Note to Physicians:** Severe systemic poisoning results primarily from uncoupling of mitochondrial oxidative phosphorylation, with ensuing hyperpyrexia. Reduce temperature and replace fluid and electrolytes lost through sweating. Treat symptomatically and supportively. *Do not* administer salicylates. Treat severe acidosis with IV sodium bicarbonate. Monitor for electrolyte imbalance, metabolic acidosis, hemolytic anemia, methemoglobinemia, pancreatitis, and liver and kidney dysfunction. Administer oxygen by mask continuously to minimize tissue anoxia.

Section 5 - Fire-Fighting Measures

Flash Point: Not applicable; noncombustible solid **Autoignition Temperature:** None reported.
LEL: None reported. **UEL:** None reported. **Flammability Classification:** Noncombustible solid

NFPA

Extinguishing Media: Use agent suitable for surrounding fire.
Unusual Fire or Explosion Hazards: May be dissolved in hydrocarbon solution.
Hazardous Combustion Products: Include hydrogen chloride (HCl) and chlorinated phenols.
Fire-Fighting Instructions: *Do not* release runoff from fire control methods to sewers or waterways. Because fire may produce toxic thermal decomposition products, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in pressure-demand or positive-pressure mode.

Section 6 - Accidental Release Measures

Spill /Leak Procedures: Notify safety personnel, evacuate all unnecessary personnel, remove heat and ignition sources. Isolate the area for at least 80 to 160 feet. Ventilate area, deny entry, stay upwind. Stop leak if you can do so without risk. Cleanup personnel should protect against exposure. **Small Spills:** If in solid form, *do not* sweep! Carefully scoop up or vacuum (with a HEPA filter). Absorb liquid spill with an inert, noncombustible absorbent such as sand or vermiculite. **Large Spills: Containment:** For large spills, dike far ahead of liquid spill for later disposal. Cover with plastic sheet to prevent dispersion. *Do not* release into sewers or waterways. **Cleanup:** If in water, apply activated carbon (10 times the spilled amount of pentachlorophenol). Remove trapped material with suction hoses. **Regulatory Requirements:** Follow applicable OSHA regulations (29 CFR 1910.120).

Section 7 - Handling and Storage

Handling Precautions: Use only with adequate ventilation to maintain concentrations at nonhazardous levels (Sec. 2). Wear personal protective clothing and equipment to prevent any contact with skin and eyes (Sec. 8), and avoid dust inhalation. Practice good personal hygiene procedures to prevent inadvertently ingesting this material. *Do not* attempt to handle broken containers without proper protective equipment. Immediately wash skin if contact with pentachlorophenol occurs. Shower and change into clean clothing after working with pentachlorophenol. **Storage Requirements:** Store in tightly closed containers in a cool, well-ventilated area away from heat, light, ignition sources, and incompatibles. Protect containers from physical damage. Outside or detached storage is preferred. **Regulatory Requirements:** Store according to USEPA hazardous waste storage regulations.

Section 8 - Exposure Controls / Personal Protection

Engineering Controls: Where feasible, enclose operations to avoid dust dispersion into the work area. Whenever possible, automatically transfer pentachlorophenol from storage containers to process containers. **Ventilation:** Provide general or local exhaust ventilation systems to maintain airborne concentrations below OSHA PEL (Sec. 2). Local exhaust ventilation is preferred. **Administrative Controls:** Educate workers about the hazards associated with this material. Train in work practices which minimize exposure. Consider preplacement and periodic medical exams with emphasis on the lungs, liver, kidneys, skin, cardiovascular and nervous systems. **Respiratory Protection:** Seek professional advice prior to respirator selection and use. Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, wear a NIOSH-approved respirator. For concentrations ≥ 2.5 mg/m^3: any chemical cartridge respirator with organic vapor cartridge(s) in combination with a dust, mist, and fume filter, or any powered, air-purifying respirator with organic vapor cartridge(s) in combination with a dust, mist and fume filter, or any supplied-air respirator, or any SCBA with a full facepiece; emergency/unknown concentrations/IDLH

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conditions: any SCBA that has a full facepiece and is operated in pressure-demand or other positive-pressure mode, or any supplied-air respirator that has a full facepiece and is operated in pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in pressure-demand or other positive-pressure mode; escape: any air-purifying, full-facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having a high-efficiency particulate filter or any appropriate escape-type SCBA. *Warning! Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.* If respirators are used, OSHA requires a written respiratory protection program that includes at least: medical certification, training, fit-testing, periodic environmental monitoring, maintenance, inspection, cleaning, and convenient, sanitary storage areas. **Protective Clothing/Equipment:** Wear chemically protective gloves, boots, aprons, and gauntlets to prevent any skin contact. Nitrile rubber and Viton™ are recommended >8, neoprene and 4H™ >4. *Do not* use natural rubber or polyvinyl alcohol. Wear dust-proof eyeglasses (solid form) or chemical safety goggles (solution), per OSHA eye- and face-protection regulations (29 CFR 1910.133). Contact lenses are not protective eye devices. Appropriate eye protection must be worn instead of, or in conjunction with, contact lenses. **Safety Stations:** Make emergency eyewash stations, safety/quick-drench showers, and washing facilities available in work area. **Contaminated Equipment:** Separate contaminated work clothes from street clothes. Launder before reuse. Segregate contaminated clothing such that cleaning personnel *do not* come in contact with pentachlorophenol. Remove this material from your shoes and clean personal protective equipment. Immediately remove contaminated clothing. **Comments:** Never eat, drink, or smoke in work areas. Practice good personal hygiene after using this material, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

Section 9 - Physical and Chemical Properties

Physical State: Solid
Appearance and Odor: White or dark gray (technical grade) crystalline solid; may be in solution.
Odor Threshold: 857 µg/L at 86 °F (30 °C) (solution)
Vapor Pressure: 0.00011 mm Hg at 77 °F (25 °C)
Vapor Density (Air=1): 9.2
Saturated Vapor Density: 1.20 kg/m^3
Formula Weight: 266.35
Specific Gravity (H_2O=1, at 4 °C): 1.978 at 22 °C/4 °C
Water Solubility: 514 mg/L at 68 °F (20 °C) (slight)
Other Solubilities: Soluble in methanol, ethanol, alcohol, pine oil, dilute alkali, and ether.
Boiling Point: 588 °F (309 °C) (decomposes)
Melting Point: 374 °F (190 °C)
Evaporation Rate: Low, calculated
Henry's Law Constant (H): 2.45 x 10^{-8} atm-m^3/mole at 77 °F
Octanol/Water Partition Coefficient: log K_{ow} = 5.12
Soil Sorption Coefficient (K_{oc}): 1000, calculated; 3000-4000 (measured, sediment)

Section 10 - Stability and Reactivity

Stability: Pentachlorophenol is stable at room temperature in closed containers under normal storage and handling conditions. **Polymerization:** Hazardous polymerization cannot occur. **Chemical Incompatibilities:** Include strong oxidizers (contact may produce fire or explosion), strong acids or bases, acid chlorides, acid anhydrides, and ultraviolet light (solution). **Conditions to Avoid:** Avoid contact with chemical incompatibles. **Hazardous Decomposition Products:** Thermal oxidative decomposition of pentachlorophenol can produce hydrogen chloride (HCl), chlorinated phenols, and carbon monoxide.

Section 11- Toxicological Information

Toxicity Data:*

Skin Effects:
Rabbit, open draize test: 10 mg/24 hr: mild irritation.

Acute Dermal Effects:
Rabbit, skin, LD_{Lo}: 40 mg/kg; toxic effects: muscle weakness; BP elevation not characterized in autonomic section; urine volume increased.
Rat, skin, LD_{50}: 96 mg/kg; toxic effects: excitement, muscle contraction or spasticity; dyspnea.

Acute Oral Effects:
Rat, oral, LD_{50}: 27 mg/kg; toxic effects: BP elevation not characterized in autonomic section; hyperglycemia; body temperature increase.
Man, oral, LD_{Lo}: 401 mg/kg; toxic effects: change in motor activity (specific assay); sweating; body temperature increase.

Multiple Dose Toxicity Data:
Rat, oral: 840 mg/kg for 12 weeks, continuous; toxic effects: changes in liver weight; changes in erythrocite (RBC) cell count; weight loss or decreased weight gain.
Rat, oral: 84 mg/kg for 28 days, intermittent; toxic effects: endocrine - other changes; changes in serum composition.

Teratogenicity:
Rat, female, oral: 60 mg/kg, administered on gestational day 9 produced effects on embryo or fetus - fetotoxicity.
Rat, female, oral: 50 mg/kg, administered on gestational days 6-15 produced specific developmental abnormalities - musculoskeletal system.

Reproductive Effects:
Rat, female, oral: 4 g/kg, administered 77 days prior to mating produced effects on newborn - weaning or lactation index; growth statistics.

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Section 11- Toxicological Information, *continued*

Acute Inhalation Effects:
Rat, inhalation, LC_{50}: 355 mg/m^3; toxic effects: excitement, muscle contraction or spasticity; dyspnea.

Tumorigenic Effects:
Mouse, oral: 8736 mg/kg for 2 years, continuous; toxic effects: tumorigenic - carcinogenic by RTECS criteria; endocrine - tumors.
Mouse, subcutaneous: 46 mg/kg; toxic effects: tumorigenic - equivocal tumorigenic agent by RTECS criteria; lungs, thorax, or respiration - tumors; liver - tumors.

Mutagenicity:
S. typhimurium, 40 nmol/plate induced mutation.
S. Cerevisiae, 400 mg/L induced mutation.

* See NIOSH, *RTECS* (SM6300000), for additional toxicity data.

Section 12 - Ecological Information

Ecotoxicity: Pentachlorophenol is highly toxic to algae, crustaceans, and fish. Trout, fresh water, 5 ppm for 3 hr: lethal. Mallard duck, LC_{50}: 4500 ppm. *Daphnia magna*, 7 day LC_{50}: 0.53 mg/L. Fathead minnow, small, 24 hr LC_{50}: 0.24 mg/L. *Poecilia reticulata*, >7 day LC_{50}: 0.38 mg/L. **Environmental Fate:** If released to soil, it will be subject to slow biodegradation and leaching into groundwater. If released in water, it will adsorb to sediment, photodegrade (especially at high pH) and slowly biodegrade. Bioconcentration in fish will be moderate. **Environmental Degradation:** In air, it will be lost due to photolysis and reaction with photochemically produced hydroxyl radicals. Half-life in soil: weeks to 3 months. **Soil Adsorption/Mobility:** Very low mobility in soil. It tends to adsorb to soil and sediment. However, leaching to groundwater is possible.

Section 13 - Disposal Considerations

Disposal: Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable federal, state, and local regulations. One method is to burn in a chemical incinerator equipped with a scrubber and ash disposal facility.
Disposal Regulatory Requirements: This material and its container must be disposed of as hazardous waste.
Container Cleaning and Disposal: Handle empty containers carefully as hazardous residues may still remain. *Do not* reuse empty containers. Combustible containers should be burned in a pesticide incinerator or disposed of in a specified landfill.

Section 14 - Transport Information

DOT Transportation Data (49 CFR 172.101):

Shipping Name: Pentachlorophenol
Shipping Symbols: –
Hazard Class: 6.1
ID No.: UN3155
Packing Group: II
Label: POISON
Special Provisions (172.102): –

Packaging Authorizations
a) Exceptions: –
b) Non-bulk Packaging: 173.212
c) Bulk Packaging: 173.242

Quantity Limitations
a) Passenger Aircraft/Railcar: 25 kg
b) Cargo Aircraft Only: 100 kg

Vessel Stowage Requirements
a) Vessel Stowage: A
b) Other: –

Section 15 - Regulatory Information

EPA Regulations:
Listed as a RCRA Hazardous Waste (40 CFR 261.33); RCRA Hazardous Waste Number: D037
Listed as a CERCLA Hazardous Substance (40 CFR 302.4) specific per (1) CWA, Sec. 311 (b)(4); (2) CWA, Sec. 307(a); (3) CAA, Sec. 112; (4) RCRA, Sec. 3001; CERCLA Final Reportable Quantity (RQ), 10 lb (4.54 kg)
Listed as a SARA Toxic Chemical (40 CFR 372.65)
SARA EHS (Extremely Hazardous Substance) (40 CFR 355): Not listed

OSHA Regulations:
Listed as an Air Contaminant (29 CFR 1910.1000, Table Z-1, Z-1-A)

Section 16 - Other Information

References: 1, 73, 99, 103, 124, 136, 176, 190, 208, 209, 216, 217, 218, 222, 223, 224, 227, 228, 230

Prepared By ..... S Fleming, BS/ DJ Wilson, CIH
Research Date: ..... 4/98 **Review Date:** 3/99
Industrial Hygiene Review ..... DJ Wilson, CIH **Medical Review** ..... G Kelafant, MD

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Section 1 - Chemical Product and Company Identification 44

Product/Chemical Name: Mercury
Chemical Formula: Hg
CAS No.: 7439-97-6
Synonyms: colloidal mercury, hydrargyrum, liquid silver, Quicksilver
Derivation: Obtained by roasting cinnabar (mercury sulfide) and purified by distillation, or as a by-product of gold mining.
General Use: Used in agricultural poisons, anti-fouling paint, dental amalgams, mining amalgamation (to remove gold and other metals from ore), thermometers, barometers, dry cell batteries, chlorine and caustic soda production, electrical apparatus, and as a neutron absorber in nuclear power plants.
Vendors: Consult the latest *Chemical Week Buyers' Guide.* (73)

Section 2 - Composition / Information on Ingredients

Mercury, ca 100 %wt

OSHA PEL
Ceiling: 0.1mg/m^3 (vapor and inorganic Hg)
8-hr TWA: 0.05 mg/m^3 (vapor), skin; (Vacated 1989 Final Rule Limit)

ACGIH TLVs
TWA: 0.025 mg/m^3 (inorganic compounds), skin

NIOSH REL
10-hr TWA: 0.05 mg/m^3 (vapor), skin

DFG (Germany) MAK
TWA: 0.01 ppm (0.1 mg/m^3)
Category III: Substances with systemic effects
Onset of Effect: > 2 hr
Half-life: > shift length (strongly cumulative)

Peak Exposure Limit:
0.1 ppm (1 mg/m^3), 30 min. average value, 1/shift

IDLH Level
28 mg/m^3

Section 3 - Hazards Identification

☆☆☆☆☆ Emergency Overview ☆☆☆☆☆

Mercury exists as a heavy, odorless, silver-white liquid metal. It is highly toxic by both acute and chronic exposure. Exposure can cause corrosion of the eyes, skin, and respiratory tract and may result in irreversible nervous system damage. It readily forms amalgamations with most metals except iron.

Wilson Risk Scale
R 1
I 4
S 2*
K 1
*Skin absorption

HMIS
H 4*
F 0
R 0
*Chronic effects
PPE†
†Sec. 8

Potential Health Effects

Primary Entry Routes: Inhalation, eye and skin contact/absorption.
Target Organs: Central nervous system, eyes, skin, respiratory system, liver, kidneys.
Acute Effects
Inhalation: Exposure to high vapor concentrations can cause severe respiratory damage. Other symptoms include wakefulness, muscle weakness, anorexia, headache, ringing in the ear, headache, diarrhea, liver changes, fever, gingivitis, chest pain, difficulty breathing, cough, inflammation of the mouth (stomatitis), salivation, bronchitis, and pneumonitis. Acrodynia (pink or Swifts disease), characterized by redness and peeling of the skin on the toes and fingers, was commonly seen in children in the 1950s and is still *infrequently* seen in workers.
Eye: Irritation and corrosion.
Skin: Skin can become severely irritated if allowed to remain in contact with mercury. Skin absorption will occur at 2.2% of the rate of absorption through the lungs.
Ingestion: Mercury generally passes through the digestive tract uneventfully. However, large amounts may get caught up in the intestine and require surgical removal. If an abscess or other perforation is present along the digestive tract, absorption into the blood stream with subsequent mercury poisoning is possible.
Carcinogenicity: IARC, NTP, and OSHA do not list mercury as a carcinogen.
Medical Conditions Aggravated by Long-Term Exposure: Central nervous system disorders.
Chronic Effects: Chronic exposure appears more common than acute and is primarily associated with central nervous system damage which can be permanent (ex. paresthesia of the hands, lips, feet). Early signs of toxicity include weakness, fatigue, anorexia, weight loss, and gastrointestinal disturbances. If exposure levels are high, characteristic tremors of the fingers, eyelids, and lips occur with progression to generalized tremors of the entire body. Psychic disorders are noticeable and characterized by behavior and personality changes, increased excitability, memory loss, insomnia, and depression. In severe cases, delirium and

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hallucinations may occur. Kidney damage is observed with oliguria (decreased urine output) progressing to anuria (urine cessation) and may require dialysis. The cornea and lens of the eyes may take on a brownish discoloration and the extraocular muscles may be damaged. This syndrome has been termed *Asthenic-Vegetative Syndrome* or *Micromercurialism.* Chronic symptoms occur increasingly with exposures to 0.1 mg/m^3 or higher. *Mutation:* Aneuploidy and other chromosomal aberrations have been observed in the lymphocytes from whole blood cultures in workers exposed to mercury. *Reproductive:* Mercury has been detected in stillborn babies of women treated with mercury for syphilis. In a study of six men acutely exposed (occupationally) to mercury levels as high as 44 mg/m^3, all suffered impaired sexual function. Repeated skin contact may cause allergic dermatitis in some individuals.

NOTE: Spilled mercury will release sufficient vapor over time to produce chronic poisoning.

Section 4 - First Aid Measures

Inhalation: Remove exposed person to fresh air and support breathing as needed.

Eye Contact: *Do not* allow victim to rub or keep eyes tightly shut. Gently lift eyelids and flush immediately and continuously with flooding amounts of water until transported to an emergency medical facility. Consult a physician immediately.

Skin Contact: *Quickly* remove contaminated clothing. Rinse with flooding amounts of water and then wash exposed area with soap. For reddened or blistered skin, consult a physician.

Ingestion: Never give anything by mouth to an unconscious or convulsing person. Contact a poison control center. In general, mercury will pass through the digestive tract uneventfully.

After first aid, get appropriate in-plant, paramedic, or community medical support.

Note to Physicians: BEI: *blood* (15 µg/L), *urine*: (35 µg/g creatinine). Extremely high urine levels of 0.5 to 0.85 mg Hg/L are indicative of polyneuropathy. 0.4 to 22 µg/L is reported to be the human lethal blood level. Obtain urinalysis including at a minimum: albumin, glucose, and a microscopic examination of centrifuged sediment. Use BAL or 2, 3-dimercaptosuccinic acid as chelators. *Do not* use calcium sodium EDTA because of nephrotoxicity. An electromyograph may determine extent of nerve dysfunction. It has been noted that exposure to mercury may predispose persons to development of carpal tunnel syndrome.

Section 5 - Fire-Fighting Measures

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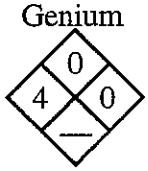

Flash Point: Nonflammable

Autoignition Temperature: Nonflammable

LEL: None reported.

UEL: None reported.

Extinguishing Media: Use agents suitable for surrounding fire.

Unusual Fire or Explosion Hazards: None reported.

Hazardous Combustion Products: Toxic mercury vapor and mercuric oxide.

Fire-Fighting Instructions: Do not release runoff from fire control methods to sewers or waterways.

Fire-Fighting Equipment: Because fire may produce toxic thermal decomposition products, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in pressure-demand or positive-pressure mode.

Section 6 - Accidental Release Measures

Spill /Leak Procedures: Keep a mercury spill kit readily available in areas where mercury is used. Notify safety personnel, isolate and ventilate area, deny entry, and stay upwind.

Small and Large Spills: Follow instructions on mercury spill kit. Most kits come with an aspiration-driven vacuum trap with a mercury "sweeper" (copper or copper-plated brush). Wash spill area with a dilute calcium sulfide or nitric acid solution. If spill cannot be taken up readily, dust the top of the spill with flowers of sulfur or preferably, calcium polysulfide. This will produce a surface coating of mercury sulfide which will reduce mercury vapor dispersion into the air.

Regulatory Requirements: Follow applicable OSHA regulations (29 CFR 1910.120).

Section 7 - Handling and Storage

Handling Precautions: Use appropriate PPE when working with mercury. *Do not* use on porous work surfaces (wood, unsealed concrete, etc.) to prevent spills from lodging in cracks.

Storage Requirements: Store in a cool, dry, well-ventilated area away from heat and incompatibles (Sec. 10). Store on non-porous floors and wash them regularly with a dilute calcium sulfide solution. Because mercury will form amalgamations with most metals except iron, metal shelves should be painted with a sufficiently thick coating to prevent this from happening.

Section 8 - Exposure Controls / Personal Protection

Engineering Controls: Wherever possible, enclose processes to prevent mercury vapor dispersion into work area.

Ventilation: Provide general or local exhaust ventilation systems to maintain airborne concentrations below OSHA PELs (Sec. 2). Local exhaust ventilation is preferred because it prevents contaminant dispersion into the work area by controlling it at its source.[103]

Administrative Controls: Consider pre-placement and periodic medical exams of exposed workers with emphasis on the skin, eyes, central nervous system, liver, and kidneys.

Respiratory Protection: Seek professional advice prior to respirator selection and use. Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, wear a MSHA/NIOSH-approved respirator. For $\leq$ 0.5 mg/m^3, use any chemical cartridge

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respirator with cartridges providing protection against mercury and equipped with an ESLI (end of service life indicator), any SCBA, or any SAR (supplied-air respirator). For ≤ 1.25 mg/m^3, use any SAR operated in continuous-flow mode, any PAPR (powered, air-purifying respirator) with an ESLI. For ≤ 2.5 mg/m^3, use any SCBA or SAR with a full facepiece, any SAR with a tight-fitting facepiece and operated in continuous-flow mode, or any chemical cartridge respirator with a full facepiece, chemical cartridges providing protection against mercury, and equipped with an ESLI. For ≤28 mg/m^3, use any SAR operated in pressure-demand or other positive-pressure mode. For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), wear an SCBA with full facepiece and operated in pressure-demand or other positive pressure mode. *Warning! Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.* If respirators are used, OSHA requires a written respiratory protection program that includes at least: medical certification, training, fit-testing, periodic environmental monitoring, maintenance, inspection, cleaning, and convenient, sanitary storage areas.

Protective Clothing/Equipment: Wear chemically protective gloves, boots, aprons, and gauntlets made of butyl rubber, nitrile rubber, fluorocarbon rubber, neoprene rubber, polyvinyl chloride, chlorinated polyethylene, or polycarbonate to prevent prolonged or repeated skin contact. Wear protective eyeglasses or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133). Contact lenses are not eye protective devices. Appropriate eye protection must be worn instead of, or in conjunction with contact lenses.

Safety Stations: Make emergency eyewash stations, safety/quick-drench showers, and washing facilities available in work area.

Contaminated Equipment: Separate contaminated work clothes from street clothes. Launder before reuse. Remove this material from your shoes and clean personal protective equipment.

Comments: Never eat, drink, or smoke in work areas. Practice good personal hygiene after using this material, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

Section 9 - Physical and Chemical Properties

Physical State: Liquid metal
Appearance and Odor: Silvery-white, odorless
Vapor Pressure: 0.0018 mm Hg at 77 °F (25 °C)
Formula Weight: 200.59
Density (H_2O=1): 13.534 g/cm^3 at 77 °F (25 °C)
Boiling Point: 674.09 °F (356.72 °C)
Freezing Point: -37.97 °F (-38.87 °C)
Viscosity: 15.5 mP at 77 °F (25 °C)
Electrical Resistivity: 95.76 µohm at 68 °F (20 °C)
Water Solubility: 0.28 µmol/L at 77 °F (25 °C)
Other Solubilities: Soluble in boiling sulfuric acid, nitric acid (reacts); slightly in lipids, and 2.7 mg/L in pentane. Insoluble in alcohol, ether, cold sulfuric acid, hydrogen bromide, and hydrogen iodide.
Surface Tension: 484 dyne/cm at 77 °F (25 °C)
Critical Temperature: 2664 °F (1462 °C)
Critical Pressure: 1587 atm

Section 10 - Stability and Reactivity

Stability: Mercury does not tarnish at ordinary temperatures but when heated to near its boiling point, it slowly oxidizes to mercuric oxide.

Polymerization: Hazardous polymerization does not occur.

Chemical Incompatibilities: Mercury forms alloys (amalgamates) with most metals except iron. It is incompatible with oxidizers such as bromine, 3-bromopropyne, methylsilane + oxygen, chlorine, chlorine dioxide, nitric acid, or peroxyformic acid; tetracarbonyl nickel + oxygen, alkynes + silver perchlorate, ethylene oxide, acetylenic compounds (explosive), ammonia (explosive), boron phosphodiiodide, methyl azide, nitromethane, and ground sodium carbide.

Conditions to Avoid: Exposure to high temperatures, metal surfaces or incompatibles.

Hazardous Decomposition Products: Thermal oxidative decomposition of mercury can produce mercuric oxide.

Section 11- Toxicological Information

Toxicity Data:*

Reproductive:
Rat, inhalation: 890 ng/m^3/24 hr for 16 weeks prior to mating had an effect on spermatogenesis.

Acute Dermal Toxicity:
Man, skin, TD_{Lo}: 129 mg/kg for 5 continuous hours caused ringing in the ears, headache, and allergic dermatitis.

Acute Oral Toxicity:
Man, oral, TD_{Lo}: 43 mg/kg caused tremor and jaundice or other liver changes.

Acute Inhalation Effects:
Woman, inhalation, TC_{Lo}: 150 µg/m^3/46 days caused anorexia, diarrhea, and wakefulness.
Man, inhalation, TC_{Lo}: 44300 µg/m^3/8 hr caused muscle weakness, liver changes, and increased body temperature.

Chronic Effects:
Rat, inhalation: 1 mg/m^3/ 24 hr for 5 continuous weeks caused proteinuria.

* See NIOSH, *RTECS* (OV4550000), for additional toxicity data.

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Section 12 - Ecological Information

Ecotoxicity: Catfish, LC_{50} = 0.35 mg/L/96 hr; mollusk (*Modiolus carvalhoi*), LC_{50} = 0.19 ppm/96 hr: tadpole (*Rana hexadactyla*), LC_{50} = 0.051 ppm/96 hr. Mercury is transformed to methyl mercury by bacteria in the environment and undergoes bioaccumulation readily. BCF for freshwater fish = 63,000; for saltwater fish = 10,000; and for marine and freshwater invertebrates = 100,000.

Environmental Degradation: Mercury is expected to volatilize rapidly when deposited on soil surfaces. Once in the air, it can be transported long distances before being redeposited on soil or in water. In water, mercury appears to bind to particulates where it eventually becomes deposited on the bed sediment. In general, mercury entering the environment can be deposited and revolatilized several times.

Section 13 - Disposal Considerations

Disposal: Incineration is *not* an appropriate disposal method. Wastewater may be treated by addition of chlorine to oxidize the mercury to its ionic state. The water can then be passed through an absorbent (an activated charcoal concentrate with a sulfur coating or peanut shell charcoal) to collect the ionic mercury, followed by distillation to recover the mercury. Sodium borohydride, a reducing agent, can be used to precipitate mercury from waste solutions. Bioremediation, using *Pseudomonas putida*, has also been suggested. Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.

Section 14 - Transport Information

DOT Transportation Data (49 CFR 172.101):

Shipping Name: Mercury
Shipping Symbols: A, W
Hazard Class: 8
ID No.: UN2809
Packing Group: III
Label: Corrosive
Special Provisions (172.102): –

Packaging Authorizations
a) Exceptions: 173.164
b) Non-bulk Packaging: 173.164
c) Bulk Packaging: 173.240

Quantity Limitations
a) Passenger, Aircraft, or Railcar: 35 kg
b) Cargo Aircraft Only: 35 kg

Vessel Stowage Requirements
a) Vessel Stowage: B
b) Other: 40, 97

Section 15 - Regulatory Information

EPA Regulations:
Listed as a RCRA Hazardous Waste (40 CFR 261.33): U151
Listed as a CERCLA Hazardous Substance (40 CFR 302.4) per RCRA, Sec. 3001; CWA, Sec. 307(a), CAA, Sec. 112
CERCLA Reportable Quantity (RQ), 1 lb (0.454 kg)
SARA 311/312 Codes: 1, 2
Listed as a SARA Toxic Chemical (40 CFR 372.65)
SARA EHS (Extremely Hazardous Substance) (40 CFR 355): Not listed
OSHA Regulations:
Listed as an Air Contaminant (29 CFR 1910.1000, Table Z-1, Z-1-A)

Section 16 - Other Information

References: 73, 103, 124, 132, 136, 148, 149, 159, 167, 176, 187, 189

Prepared By ..... M Gannon, BA
Industrial Hygiene Review ..... RE Langford, PhD, CIH
Medical Review ..... T Thoburn, MD, MPH

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Material Safety Data Sheets Collection:

Sheet No. 296
Arsenic and Compounds

Issued: 4/90

Section 1. Material Identification

Arsenic Description: Obtained from flue dust of copper and lead smelters as white arsenic (arsenic trioxide). Reduction with charcoal and sublimation in an N_2 current yields pure arsenic. Metallic arsenic is used for hardening copper, lead, and alloys; as a doping agent in germanium and silicon solid-state products, special solders, and medicine; and to make gallium arsenide for dipoles and other electronic devices. Arsenic compounds are used in manufacturing certain types of glass; in textile printing, tanning, taxidermy, pharmaceuticals, insecticides and fungicides, pigment production, and antifouling paints; and to control sludge formation in lubricating oils. Arsenic trioxide is the source for 97% of all arsenic products.
Other Designations: CAS No. 7440-38-2; arsen; arsenic black; As; gray arsenic; metallic arsenic.
Manufacturer: Contact your supplier or distributor. Consult the latest *Chemicalweek Buyers' Guide*[73] for a suppliers list.

R	1
I	4
S	2
K	0

Genium

HMIS
H 3
F 2
R 2
PPG*
* Sec. 8

Section 2. Ingredients and Occupational Exposure Limits

Arsenic and soluble compounds, as As

OSHA PEL
8-hr TWA: 0.5 mg/m³,* 0.01 mg/m³†

ACGIH TLV, 1989-90
TLV-TWA: 0.2 mg/m³

NIOSH REL, 1987
Ceiling: 0.002 mg/m³

Toxicity Data‡
Man, oral, TD_{Lo}: 76 mg/kg administered intermittently over a 12-year period affects the liver (tumors) and blood (hemorrhage)
Man, oral: 7857 mg/kg administered over 55 years produces gastrointestinal (in the structure or function of the esophagus), blood (hemorrhage), and skin and appendage (dermatitis) changes
Rat, oral, TC_{Lo}: 605 µg/kg administered to a 35-week pregnant rat affects fertility (pre- and post-implantation mortality)

* Organic compounds.
† Inorganic compounds.
‡ See NIOSH, *RTECS* (CG0525000), for additional mutative, reproductive, tumorigenic, and toxicity data.

Section 3. Physical Data*

Boiling Point: sublimes at 1134 °F/612 °C
Melting Point: 1497 °F/814 °C
Vapor Pressure: 1 mm at 702 °F/372 °C (sublimes)
Atomic Weight: 74.92
Density: 5.724 at 57 °F/14 °C
Water Solubility: Insoluble†

Appearance and Odor: A brittle, crystalline, silvery to black metalloid. Odorless.

* This data pertains to arsenic only.
† Arsenic is soluble in nitric acid (HNO_3).

Section 4. Fire and Explosion Data

Flash Point: None reported	Autoignition Temperature: None reported	LEL: None reported	UEL: None reported

Extinguishing Media: Use dry chemical, CO_2, water spray, or foam to fight fires.
Unusual Fire or Explosion Hazards: Flammable and slightly explosive in the form of dust when exposed to heat or flame.
Special Fire-fighting Procedures: Since fire may produce toxic fumes, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in the pressure-demand or positive-pressure mode. Be aware of runoff from fire control methods. Do not release to sewers or waterways.

Section 5. Reactivity Data

Stability/Polymerization: Arsenic is stable at room temperature in closed containers under normal storage and handling conditions. Hazardous polymerization cannot occur.
Chemical Incompatibilities: Arsenic can react vigorously on contact with powerful oxidizers such as bromates, peroxides, chlorates, iodates, lithium, silver nitrate, potassium nitrate, potassium permanganate, and chromium (VI) oxide. This material is also incompatible with halogens, bromine azide, palladium, dirubidium acetylide, zinc, and platinum.
Hazardous Products of Decomposition: Thermal oxidative decomposition of arsenic and its compounds produces irritating or poisonous gases.

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Section 6. Health Hazard Data

Carcinogenicity: The IARC, NTP, and OSHA list arsenic as a human carcinogen (Group 1). This evaluation applies to arsenic and arsenic compounds as a whole, and not necessarily to all individual chemicals within the group. Studies report that both the trivalent and pentavalent compounds are strongly implicated as causes of skin, lung, and lymphatic cancers. Experimental studies have shown that arsenic has tumorigenic and teratogenic effects in laboratory animals.
Summary of Risks: Arsenic compounds are irritants of the skin, mucous membranes, and eyes. The moist mucous membranes are most sensitive to irritation. Prolonged contact results in local hyperemia (blood congestion) and later vesicular or pustular eruption. Epidermal carcinoma is a reported risk of exposure. Peripheral neuropathy (degenerative state of the nervous system) is common after acute or chronic arsenic poisoning. Symptoms include decreased sensation to touch, pinprick, and temperature; loss of vibration sense; and profound muscle weakness and wasting. Other complications of acute and chronic arsenic poisoning are encephalopathy (alterations of brain structure) and toxic delirium.
Medical Conditions Aggravated by Long-Term Exposure: Damage to the liver, nervous, and hematopoietic (responsible for the formation of blood or blood cells in the body) system may be permanent. Pulmonary and lymphatic cancer may also occur.
Target Organs: Liver, kidneys, skin, lungs, lymphatic system.
Primary Entry Routes: Inhalation, ingestion of dust and fumes, via skin absorption.
Acute Effects: Acute industrial intoxication is more likely to arise from inhalation of arsine. However, with corrosive arsenical vapors, conjunctivitis, eyelid edema, and even corneal erosion may result. Inhalation may result in nasal irritation with perforation of the septum, cough, chest pain, hoarseness, pharyngitis, and inflammation of the mouth. If ingested, metallic or garlic taste, intense thirst, nausea, vomiting, abdominal pain, diarrhea, and cardiovascular arrhythmias (heartbeat irregularities) may occur. Symptoms generally occur within 30 minutes, but may be delayed for several hours if ingested with food. Acute poisoning may result in acute hemolysis (breakdown of red blood cells).
Chronic Effects: Chronic symptoms include weight loss, hair loss, nausea, and diarrhea alternating with constipation, palmar and plantar hyperkeratoses (thickening of the corneous layer of skin on palms and soles of feet), and skin eruptions, and peripheral neuritis (inflammation of the nerves). Leukemia, bone marrow depression, or aplastic anemia (dysfunctioning of blood-forming organs) may occur after chronic exposure.
FIRST AID
Eyes: Flush immediately, including under the eyelids, gently but thoroughly with flooding amounts of running water for at least 15 min.
Skin: *Quickly* remove contaminated clothing. After rinsing affected skin with flooding amounts of water, wash it with soap and water.
Inhalation: Remove exposed person to fresh air and support breathing as needed.
Ingestion: Never give anything by mouth to an unconscious or convulsing person. If ingested, have a *conscious* person drink 1 to 2 glasses of water, then induce repeated vomiting until vomit is clear.
After first aid, get appropriate in-plant, paramedic, or community medical support.
Physician's Note: If emesis is unsuccessful after two doses of Ipecac, consider gastric lavage. Monitor urine arsenic level. Alkalinization of urine may help prevent disposition of red cell breakdown products in renal tubular cells. If acute exposure is significant, maintain high urine output and monitor volume status, preferably with central venous pressure line. Abdominal X-rays should be done routinely for all ingestions. Chelation therapy with BAL, followed by n-penicillamine is recommended, but specific dosing guidelines are not clearly established.

Section 7. Spill, Leak, and Disposal Procedures

Spill/Leak: Notify safety personnel of spill, evacuate all unnecessary personnel, remove all heat and ignition sources, and provide adequate ventilation. Cleanup personnel should protect against dust inhalation and contact with skin and eyes. Use nonsparking tools. With a clean shovel, scoop material into a clean, dry container and cover. Absorb liquid material with sand or noncombustible inert material and place in disposal containers. Do not release to sewers, drains, or waterways. Follow applicable OSHA regulations (29 CFR 1910.120).
Disposal: Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.

EPA Designations*
RCRA Hazardous Waste (40 CFR 261.33): Not listed
Listed as a CERCLA Hazardous Substance† (40 CFR 302.4), Reportable Quantity (RQ): 1 lb (0.454 kg) [† per Clean Water Act, Sec. 307(a); per Clean Air Act, Sec. 112]
SARA Extremely Hazardous Substance (40 CFR 355): Not listed
Listed as a SARA Toxic Chemical (40 CFR 372.65)

OSHA Designations‡
Air Contaminant (29 CFR 1910.1000, Subpart Z): Not listed

* Designations for arsenic only.
‡ Listed as arsenic organic compounds (as As).

Section 8. Special Protection Data

Goggles: Wear protective eyeglasses or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133).
Respirator: Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, wear a NIOSH-approved respirator. For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), wear an SCBA.
Warning: Air-purifying respirators do *not* protect workers in oxygen-deficient atmospheres.
Other: Wear impervious gloves, boots, aprons, and gauntlets to prevent skin contact.
Ventilation: Provide general and local explosion-proof ventilation systems to maintain airborne concentrations below the OSHA PELs, ACGIH TLVs, and NIOSH REL (Sec. 2). Local exhaust ventilation is preferred since it prevents contaminant dispersion into the work area by controlling it at its source.[103]
Safety Stations: Make available in the work area emergency eyewash stations, safety/quick-drench showers, and washing facilities.
Contaminated Equipment: Never wear contact lenses in the work area: soft lenses may absorb, and all lenses concentrate, irritants. Remove this material from your shoes and equipment. Launder contaminated clothing before wearing.
Comments: Never eat, drink, or smoke in work areas. Practice good personal hygiene after using this material, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

Section 9. Special Precautions and Comments

Storage Requirements: Store in closed, properly labeled, containers in a cool, well-ventilated area away from all incompatible materials (Sec. 5) and heat and ignition sources. Protect containers from physical damage.

Engineering Controls: Avoid inhalation or ingestion of dust and fumes, and skin or eye contact. Practice good personal hygiene and housekeeping procedures. Use only with adequate ventilation and appropriate personal protective gear. Institute a respiratory protection program with training, maintenance, inspection, and evaluation. All engineering systems should be of maximum explosion-proof design and electrically grounded and bonded. Provide preplacement and annual physical examination with emphasis on the skin, respiratory system, and blood.

Transportation Data (49 CFR 172.101, .102)

DOT Shipping Name: Arsenic, solid
DOT Hazard Class: Poison B
ID No.: UN1558
DOT Label: Poison
DOT Packaging Requirements: 173.366
DOT Packaging Exceptions: 173.364

IMO Shipping Name: Arsenic, metallic
IMO Hazard Class: 6.1
IMO Label: Poison
IMDG Packaging Group: II
ID No.: UN1558

MSDS Collection **References:** 7, 26, 38, 53, 73, 85, 87, 88, 89, 100, 103, 109, 123, 124, 126, 127, 130, 136, 138
Prepared by: MJ Allison, BS; **Industrial Hygiene Review:** DJ Wilson, CIH; **Medical Review:** MJ Hardies, MD M4

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Material Safety Data Sheets Collection:

Sheet No. 83
Chromium Metal/Powder

Issued: 3/81 Revision: A, 11/89

Section 1. Material Identification 30

Chromium Metal/Powder Description: Obtained from chrome ore, chromite ($FeCr_2O_4$), by electrolysis of chromium solutions, by direct reduction (ferrochrome), and by reducing the oxide with finely divided carbon or aluminum. Used for chromeplating other metals; for greatly increasing metal resistance and durability; in manufacturing chrome-steel or chrome-nickel-steel alloys (stainless steel); as a constituent of inorganic pigments; as protective coating for automotive and equipment accessories; and in nuclear and high-temperature research.
Other Designations: Chrome; Cr; CAS No. 7440-47-3.
Manufacturer: Contact your supplier or distributor. Consult the latest *Chemicalweek Buyers' Guide* (Genium ref. 73) for a suppliers list.

R 1
I 4
S 1
K 1

Genium

HMIS
H 2
F 1
R 1
PPG*
* Sec. 8

Section 2. Ingredients and Occupational Exposure Limits

Chromium metal/powder, ca 100%

OSHA PEL	ACGIH TLV, 1988-89*	NIOSH REL, 1987†	Toxicity Data‡
8-hr TWA: 1 mg/m³	TLV-TWA: 0.5 mg/m³	8-hr TWA (for chromium metal and insoluble salts): 1 mg Cr/m³	Rat, implant, TD_{Lo}: 1200 µg/kg body weight administered intermittently over six weeks

* This TLV is applicable to Cr^{+2} and Cr^{+3} compounds. For water soluble and water-insoluble Cr^{+6}, the 8-hr TWA is 0.05 mg Cr^{+6}/m^3. Certain water-insoluble Cr^{+6} compounds (zinc chromate, calcium chromate, lead chromate, barium chromate, strontium chromate, and sintered chromium trioxide) are designated as A1a (human carcinogen).
† The NIOSH REL (10-hr TWA) for carcinogen Cr^{+6} compounds is 1 µg/m³; for noncarcinogenic Cr^{+6} compounds (including chromic acid), the RELs (10-hr TWAs) are 25 µg/m³ and 50 µg/m³ (15-min ceiling). The noncarcinogenic compounds include mono- and dichromates of hydrogen, cesium, sodium, lithium, potassium, rubidium, ammonia, and Cr^{+6} (chromic acid anhydride). Any and all Cr^{+6} materials excluded from the noncarcinogenic group above are carcinogenic Cr^{+6} compounds.
‡ See NIOSH, *RTECS* (GB4200000), for additional data with references to tumorigenic effects.

Section 3. Physical Data

Boiling Point: 4788 °F (2642 °C)
Melting Point: 3452 °F (1900 °C)
Vapor Pressure: 1 mm Hg at 2941 °F (1616 °C)
Vapor Density (Air = 1): 1.79
Atomic Weight: 51.996 g/mol
Specific Gravity (H_2O = 1 at 39 °F (4 °C)): 7.2 at 68 °F (20 °C)
Water Solubility: Insoluble

Appearance and Odor: Steel-gray, lustrous metal; no odor.

Section 4. Fire and Explosion Data

Flash Point: None reported	Autoignition Temperature: Cloud, 1076 °F (580 °C); dust layer, 752 °F (400 °C)	LEL: Dust cloud explosion, 0.230 oz/ft³	UEL: None reported

Extinguishing Media: Use dry chemical or sand.
Unusual Fire or Explosion Hazards: Particle size and dispersion in air determine reactivity. Chromium powder explodes spontaneously in air, while chromium dust suspended in CO_2 is ignitable and explosive when heated.
Special Fire-fighting Procedures: Wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in the pressure-demand or positive-pressure mode.

*One hundred percent of dust goes through a 74-µm sieve. A 140-mJ spark can ignite a dust cloud.

Section 5. Reactivity Data

Stability/Polymerization: Chromium is stable when properly handled and stored. Hazardous polymerization cannot occur.
Chemical Incompatibilities: Chromium reacts readily with dilute, not nitric, acids to form chromous salts. It is soluble in acids (not nitric) and strong alkalis. Its powder is incompatible with strong oxidizing agents, including high O_2 concentration. Evaporation of mercury (Hg) from Cr amalgam leaves pyrophoric chromium. Finely divided Cr attains incandescence with nitrogen oxide, potassium chlorate, and sulfur dioxide. Molten lithium at 18 °C severely attacks Cr. Fused ammonium nitrate below 200 °C reacts explosively and may ignite or react violently with bromine pentafluoride.
Hazardous Products of Decomposition: Thermal oxidative decomposition of Cr can produce toxic chromium oxide fumes.

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Section 6. Health Hazard Data

Carcinogenicity: The NTP and OSHA list chromium as a human carcinogen.

Summary of Risks: When ingested chromium is a human poison, with gastrointestinal (GI) effects. Chromium 3 (Cr^{+3}) compounds show little or no toxicity. Less soluble chromium 6 (Cr^{+6}) compounds are suspected carcinogens and severe irritants of the larynx, nasopharynx, lungs, and skin (Sec. 2). Chromic acid or chromate salts cause irritation of the skin and respiratory passage. Ingestion leads to severe irritation of the gastrointestinal tract, renal damage, and circulatory shock. Chromium metal (when heated to high temperatures) and insoluble salts are said to be involved in histological fibrosis of the lungs, which may progress to clinically evident pneumoconiosis. Exposure to chromate dust and powder can cause skin (dermatitis) and eye irritation (conjunctivitis).

Medical Conditions Aggravated by Long-Term Exposure: An incresed incidence of bronchogenic carcinoma occurs in workers exposed to chromate dust.

Target Organs: Respiratory system.

Primary Entry: Inhalation, percutaneous absorption, and ingestion.

Acute Effects: Acute exposures to dust may cause headache, coughing, shortness of breath, pneumoconiosis, fever, weight loss, nasal irritation, inflammation of the conjunctiva, and dermatitis.

Chronic Effects: Asthmatic bronchitis.

FIRST AID

Eyes: Flush immediately, including under the eyelids, gently but thoroughly with flooding amounts of running water for at least 15 min.

Skin: Brush off chromium dust. After rinsing affected area with flooding amounts of water, wash it with soap and water.

Inhalation: Remove exposed person to fresh air and support breathing as needed.

Ingestion: Never give anything by mouth to an unconscious or convulsing person. If ingested, have that conscious person slowly drink 1 to 2 glasses of water to dilute. Do not induce vomoting. A physician should evaluate all ingestion cases.

After first aid, get appropriate in-plant, paramedic, or community medical attention and support.

Physician's Note: Acute toxicity causes a two-phase insult: 1) multisystem shock due to gastrointestinal corrosivity and 2) hepatic, renal, hematopoetic insult. Treatment should use ascorbic acid as a neutralizer with gastric lavage. If the ingestion is substantial, exchange transfusions and/or consider hemodialysis. Treat allergic dermatitis with local cortisone or 10% ascorbic acid to reduce Cr^{+6} to Cr^{+3}. Ten percent EDTA in a lanolin base applied every 24 hr helps heal skin ulcers.

Section 7. Spill, Leak, and Disposal Procedures

Spill/Leak: Notify safety personnel of large spills. Cleanup personnel should wear protective clothing and approved respirators. Remove heat and ignition sources. Provide adequate ventilation. Keep airborne dust at a minimum. Remove spills quickly and place in appropriate containers for disposal or reuse.

Disposal: Reclaim salvageable metal. Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.

OSHA Designations

Listed as an Air Contaminant (29 CFR 1910.1000, Table Z-1)

EPA Designations

RCRA Hazardous Waste (40 CFR 261.33): Not listed

Listed as a CERCLA Hazardous Substance* (40 CFR 302.4), Reportable Quantity (RQ): 1 lb (0.454 kg) [* per Clean Water Act, Sec. 307(a)]

SARA Extremely Hazardous Substance (40 CFR 355): Not listed

Listed as a SARA Toxic Chemical (40 CFR 372.65)

Section 8. Special Protection Data

Goggles: Wear protective eyeglasses or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133).

Respirator: Wear a NIOSH-approved respirator if necessary. Wear an SCBA with a full facepiece when the particle concentration's upper limit is 50 mg/m^3.

Warning: Air-purifying respirators do *not* protect workers in oxygen-deficient atmospheres.

Other: Wear impervious rubber gloves, boots, aprons, and gauntlets to prevent prolonged or repeated skin contact.

Ventilation: Provide general and local explosion-proof ventilation systems to maintain airborne concentrations below the OSHA standard (Sec. 2). Local exhaust ventilation is preferred since it prevents contaminant dispersion into the work area by eliminating it at its source (Genium ref. 103).

Safety Stations: Make available in the work area emergency eyewash stations, safety/quick-drench showers, and washing facilities.

Contaminated Equipment: Never wear contact lenses in the work area: soft lenses may absorb, and all lenses concentrate, irritants. Launder contaminated clothing before wearing. Remove this material from your shoes and equipment.

Comments: Never eat, drink, or smoke in work areas. Practice good personal hygiene after using this material, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

Section 9. Special Precautions and Comments

Storage Requirements: Store material in cool, dry, well-ventilated area separate from acids and oxidizing agents. Seal and protect containers from physical damage. Keep away from heat or ignition sources.

Engineering Controls: Avoid dust inhalation. Practice good housekeeping (vacuuming and wet sweeping) to minimize airborne particulates and to prevent dust accumulation. Use nonsparking tools and ground electrical equipment and machinery.

Transportation Data (49 CFR 172.101, .102): Not listed

MSDS Collection References: 1, 2, 26, 38, 80, 87, 88, 89, 100, 109, 124, 126

Prepared by: MJ Allison, BS; **Industrial Hygiene Review:** DJ Wilson, CIH; **Medical Review:** MJ Hardies, MD

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Material Safety Data Sheet Collection

Chromium (III) Oxide **MSDS No. 182**

Date of Preparation: 4/86 Revision: A, 6/94

Section 1 - Chemical Product and Company Identification 44

Product/Chemical Name: Chromium (III) Oxide
Chemical Formula: Cr_2O_3
CAS No.: 1308-38-9
Synonyms: chrome green, chrome oxide, chromic oxide, chromium sesquioxide, chromium (3^+) trioxide, dichromium trioxide, green cinnabar, oxide of chromium
Derivation: Prepared by reaction of sodium dichromate or chromate with sulfur or by heating chromic hydroxide or dry ammonium dichromate.
General Use: Used in abrasives, electrical semiconductors, alloys; for printing fabrics and bank notes; as a component of refractory bricks and green asphalt roofing, sensitizer in photochemical processing, a colorant for latex paints, cement, paper, and rubber, and as a catalyst in preparation of methanol, butadiene, and high density polyethylene.
Vendors: Consult the latest *Chemical Week Buyers' Guide.* (73)

Section 2 - Composition / Information on Ingredients

Chromium (III) Oxide, > 95.5 % wt.
Trace Impurities: moisture 0.3%, iron 0.05%, sulfur 0.2%, inert material 0.75%, other water soluble material 0.2%.

OSHA PEL
Chromium (III) compounds, as Cr
8-hr TWA: 0.5 mg/m^3

NIOSH REL
Chromium (II) & (III) compounds, as Cr
10-hr TWA: 0.5 mg/m^3

DFG (Germany) MAK
None established

ACGIH TLV
Chromium (III) compounds, as Cr
8-hr TWA: 0.5 mg/m^3

Section 3 - Hazards Identification

☆☆☆☆☆ Emergency Overview ☆☆☆☆☆

Chromium (III) oxide exists as small green crystals or powder. It has very low toxicity due to poor membrane (skin and mucous membrane) permeability. Chromium (III) oxide is not combustible itself, but as an oxidizer it is capable of igniting combustible materials and increasing the intensity of a fire.

Wilson Risk Scale
R 1
I 3
S 1
K 0

HMIS
H 1
F 0
R 0

PPE*
*Sec. 8

Potential Health Effects

Primary Entry Routes: Inhalation, skin and eye contact.
Target Organs: Skin, eyes, respiratory tract.
Acute Effects
Inhalation: May cause minor irritation of the respiratory tract.
Eye: May cause minor irritation.
Skin: May cause minor irritation.
Ingestion: When taken orally, trivalent chromium compounds do not produce any local or systemic effects because of poor absorption.
Carcinogenicity: NTP and OSHA do not list chromium (III) oxide as a carcinogen. IARC has evaluated chromium (III) oxide and designated it as Class 3, unclassifiable as to human carcinogenicity. In general, hexavalent (VI) chromium compounds have been found to be carcinogenic, but trivalent (III) compounds have not.
Medical Conditions Aggravated by Long-Term Exposure: Possibly, dermatitis.
Chronic Effects: Dermatitis is possible in sensitive individuals. In a case study of 85 chrome factory workers exposed to 4.5 to 9.2 mg/m^3 of chromium (III) compounds, 18.8% developed chronic bronchitis after 5 yr and 5.9% developed pneumoconiosis after 9 yr.

Section 4 - First Aid Measures

Inhalation: Remove exposed person to fresh air and support breathing as needed.
Eye Contact: *Do not* allow victim to rub or keep eyes tightly shut. Gently lift eyelids and flush immediately and continuously with flooding amounts of water for at least 15 minutes. If pain or irritation persists, consult an ophthalmologist.
Skin Contact: *Quickly* remove contaminated clothing. Rinse with flooding amounts of water followed by a soap and water wash.
Ingestion: Never give anything by mouth to an unconscious or convulsing person. Contact a poison control center. Unless the poison control center advises otherwise, have the *conscious and alert* person drink 1 to 2 glasses of water to dilute.
After first aid, get appropriate in-plant, paramedic, or community medical support.

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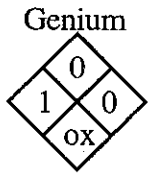
Note to Physicians: Urinary excretion is generally < 10 µg/day in absence of excess exposure. Treat weeping dermatitis with 1% aluminum acetate wet dressings.

Section 5 - Fire-Fighting Measures



Flash Point: Noncombustible
Autoignition Temperature: Noncombustible
LEL: None reported.
UEL: None reported.
Extinguishing Media: Use agents suitable for surrounding fire.
Unusual Fire or Explosion Hazards: Although chromium (III) oxide is noncombustible, it is an oxidizer capable of igniting combustible materials and increasing the intensity of a fire.
Hazardous Combustion Products: None
Fire-Fighting Instructions: Do not release runoff from fire control methods to sewers or waterways.
Fire-Fighting Equipment: Because fire may produce toxic thermal decomposition products, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in pressure-demand or positive-pressure mode.

Section 6 - Accidental Release Measures

Spill /Leak Procedures: Notify safety personnel, isolate and ventilate area, deny entry, and stay upwind. Cleanup personnel should protect against inhalation and skin/eye contact. Immediate clean-up is necessary to prevent dust dispersion.
Small Spills: Damp mop or vacuum (with appropriate filter). *Do not* sweep!
Large Spills
Containment: Flush spills with water to containment area for reclamation or disposal. *Do not* release into sewers or waterways.
Cleanup: Damp mop any residue.
Regulatory Requirements: Follow applicable OSHA regulations (29 CFR 1910.120).

Section 7 - Handling and Storage

Handling Precautions: Prevent dust dispersion.
Storage Requirements: Store in a cool, dry, well-ventilated area away from incompatibles (Sec. 10). *Do not* store on wooden floors or shelves (oxidizer - capable of igniting combustible materials).

Section 8 - Exposure Controls / Personal Protection

Engineering Controls: Enclose all processes where possible to prevent dust dispersion into work area.
Ventilation: Provide general or local exhaust ventilation systems to maintain airborne levels below OSHA PELs (Sec. 2). Local exhaust ventilation is preferred because it prevents contaminant dispersion into the work area by controlling it at its source.[103]
Administrative Controls: Consider preplacement and periodic (annual) medical exams of exposed workers with emphasis on the respiratory system (including a 14" x 17" chest roentgenogram and FVC/FEV).
Respiratory Protection: Seek professional advice prior to respirator selection and use. Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, wear a MSHA/NIOSH-approved respirator. For ≤ 2.5 mg/m^3, use any dust and mist respirator. For ≤ 5 mg/m^3, use any dust and mist respirator except single-use and quarter mask respirators; any supplied-air respirator (SAR); or any SCBA. For ≤ 12.5 mg/m^3, use any powered, air-purifying respirator with a dust and mist filter or any SAR operated in continuous-flow mode. For ≤ 25 mg/m^3, use any air-purifying, full facepiece respirator with a high-efficiency particulate filter; any powered, air-purifying respirator with a tight-fitting facepiece and a high-efficiency particulate filter; or any SAR or SCBA with a full facepiece. For ≤ 250 mg/m^3, use any SAR with a full facepiece and operated in pressure demand or other positive-pressure mode. For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), wear an SCBA. *Warning! Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.* If respirators are used, OSHA requires a written respiratory protection program that includes at least: medical certification, training, fit-testing, periodic environmental monitoring, maintenance, inspection, cleaning, and convenient, sanitary storage areas.
Protective Clothing/Equipment: Wear chemically protective gloves, boots, aprons, and gauntlets to prevent prolonged or repeated skin contact. Wear protective eyeglasses or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133). Contact lenses are not eye protective devices. Appropriate eye protection must be worn instead of, or in conjunction with contact lenses.
Safety Stations: Make emergency eyewash stations, safety/quick-drench showers, and washing facilities available in work area.
Contaminated Equipment: Separate contaminated work clothes from street clothes. Launder before reuse. Remove chromium (III) oxide from your shoes and clean personal protective equipment.
Comments: Never eat, drink, or smoke in work areas. Practice good personal hygiene after using chromium (III) oxide, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

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Section 9 - Physical and Chemical Properties

Physical State: Solid
Appearance and Odor: Light to dark green, fine, hexagonal crystals or powder which turn brown upon heating. The crystals will scratch quartz, topaz, or zircon.
Formula Weight: 152.02
Specific Gravity (H_2O=1, at 4 °C): 5.21
Water Solubility: Nearly insoluble
Other Solubilities: Practically insoluble in alcohol and acetone. Slightly soluble in acids and alkalis.
Boiling Point: 7232 °F (4000 °C)
Melting Point: 4415 °F (2435 °C)
Refractive Index: 2.551

Section 10 - Stability and Reactivity

Stability: Chromium (III) oxide is stable at room temperature in closed containers under normal storage and handling conditions.
Polymerization: Hazardous polymerization does not occur.
Chemical Incompatibilities: Chromium (III) oxide is reduced to the 2+ oxidation state by hypophosphites, electrolysis, or reducing metals such as zinc, magnesium, and aluminum in acid solution. It is incompatible with lithium + heat 1769 °F (965 °C), oxygen difluoride, glycerol (explodes), chlorine trifluoride, and rubidium acetylide.
Conditions to Avoid: Exposure to incompatibles and dispersion of dusts into air.
Hazardous Decomposition Products: None reported.

Section 11- Toxicological Information

Toxicity Data:*

Carcinogenicity:
Rat, intraperitoneal: 90 mg/kg caused respiratory and kidney tumors.
Mutagenicity:
Hamster, lung cell: 34 mg/L caused sister chromatid exchange.
* See NIOSH, *RTECS* (GB6475000), for additional toxicity data.

Section 12 - Ecological Information

Ecotoxicity: There is little tendency for bioaccumulation along the food chain. The BCF (chromium III compounds) for saltwater organisms = 86 to 153.
Environmental Degradation: In water, chromium (III) oxide is expected to eventually precipitate to sediments. The estimated residence time of *chromium* in lake water is 4.6 to 18 yr. In air, chromium (III) oxide is primarily removed by fallout and precipitation. Soils with a high chromium (all compounds included) content (> 0.2%) are expected to be infertile. The half-life of chromium in soils may be several years.

Section 13 - Disposal Considerations

Disposal: Chromium (III) oxide is a poor candidate for incineration. Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.

Section 14 - Transport Information

DOT Transportation Data (49 CFR 172.101): Not listed

Section 15 - Regulatory Information

EPA Regulations:
RCRA Hazardous Waste Classification (40 CFR 261.21): D001, Characteristic of Ignitability (oxidizer).
Listed as (chromium compounds) a CERCLA Hazardous Substance (40 CFR 302.4) CWA, Sec. 311 (b)(4)
CERCLA *Statutory* Reportable Quantity (RQ), 1 lb (0.454 kg)
Listed as (chromium compounds) a SARA Toxic Chemical (40 CFR 372.65)
SARA EHS (Extremely Hazardous Substance) (40 CFR 355): Not listed
OSHA Regulations:
Listed as an Air Contaminant (29 CFR 1910.1000, Table Z-1, Z-1-A)

Section 16 - Other Information

References: 73, 103, 124, 132, 136, 148, 149, 167, 176, 187, 189, 192

Prepared By.....M Gannon, BA
Industrial Hygiene Review .....DJ Wilson, CIH
Medical Review .....T Thoburn, MD, MPH

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ATTACHMENT B

Site Forms

URS SMS Form 29-1 Hazard Assessment Certification Form

URS SMS Form 24-9 Field First Aid Kit Supply List

URS SMS Form 49-1 Incident Report Form

USACE Eng Form 3394

URS Corporation

URS Corporation Health & Safety Program
HAZARD ASSESSMENT CERTIFICATION FORM

Location:_____ **Job No:**_____

Date : _____ **Assessment Conducted by:** _____

Specific tasks performed at this location: _____

_____

	Are any of the following present during the task?	No	Yes (Hazard Present)	Eliminate Hazard or Use Following PPE
	Overhead Hazards			
1.	Suspended loads that could fall			Hard hat, ANSI Class A, B
2.	Overhead beams or load that could strike head			Hard hat, ANSI Class A, B
3.	Energized wires or equipment that could strike head			Hard hat, ANSI Class B
4.	Employees working above at an elevated site who could drop objects on others below			Hard hat, ANSI Class A, B
5.	Sharp objects or corners at head level			Hard hat, ANSI Class A, B or C
	Eye Hazards			
6.	Chemical splashes or irritating mists			Chemical protective goggles See Attachment 29-3
7.	Excessive dust			Safety glasses or impact goggles
8.	Smoke & fumes			Chemical protective goggles
9.	Welding operations			See Attachment 29-3 and 29 T-1
10.	Lasers/optical radiation			See Attachment 29-3 and Reference F
11.	Projectiles			See Attachment 29-3
12.	Sawing, cutting, chipping, grinding			See Attachment 29-3
	Face Hazards			
13.	Chemical splashes or irritating mists			Face shield if chemical is irritating to the skin or is corrosive. See Attachment 29-3
14.	Welding operations			See Attachment 29-3 and 29-T1
15.	Projectiles			See Attachment 29-3 and face shield
	Hand Hazards			
16.	Chemical exposure			Use resistant gloves as recommended by manufacturer - See Best Chemrest Guide
17.	Sharp edges, splinters, etc.			Leather gloves

Location :_____**Job No:**_____

	Are any of the following present during the task?	No	Yes (Hazard Present)	Eliminate Hazard or Use Following PPE
18.	Temperature extremes - heat			Leather gloves; hot mill gloves; Kevlar gloves, welders' gloves
19.	Temperature extremes - cold			Leather gloves; insulated gloves
20.	Blood, fungus			Nitrile gloves
21.	Exposure to live electrical current			Electrical gloves - See Reference H
22.	Sharp tools, machine parts, etc.			Leather gloves, kevlar gloves
23.	Material handling			Leather gloves
	Foot Hazards			
24.	Heavy materials (greater than 50 pounds) handled by employees			Safety shoes or boots
25.	Potential to crush whole foot			Safety shoes or boots with metatarsal guard
26.	Sharp edges or points - puncture risk			Safety shoes or boots
27.	Exposure to electrical wires			Safety shoes or boots with electrical protection
28.	Unusually slippery conditions			Rubber soled boots or grips
29.	Chemical contamination			Rubber, nitrile boots or boot covers
30.	Wet conditions			Rubber boots or boot covers
31.	Construction/demolition			Safety shoes or boots with metatarsal guard if who foot crushing hazard exists.
	Fall Hazards			
32.	Elevations above 6 feet without guardrails			Full body harness, ANSI A-10.14 - 1991 - See Reference G
33.	Suspended scaffolds, boatswain's chairs, float scaffolds, suspended staging.			ANSI Type II - full body harness - See Reference G
34.	Working in trees			ANSI Type I full body harness - See Reference G
35.	Working in vehicle mounted, elevating work platforms (bucket trucks, pin-on platforms, etc.)			ANSI Type II full body harness - see Reference G
	Water Hazards			
36.	Working on or above water where drowning hazards exist			U.S. Coast Guard approved personal flotation device, Type I, II, or III PFD
	Excessive Heat or Flame			
37.	Full body chemical protective clothing in temperatures greater than 80 degrees			Cooling vest
38.	Work around molten metal or flame			Nomex or kevlar clothing

Location :_____Job No:_____

	Are any of the following present during the task?	No	Yes (Hazard Present)	Eliminate Hazard or Use Following PPE
39.	Welding activities			Welding leathers for those areas that are exposed to flame, spark or molten metal
	Respiratory Hazards			
40.	See SMS for RESPIRATORY PROTECTION for selection guidance			
	Excessive Noise			
41.	Exposure to noise			Ear plugs or muffs
	Body and Leg Protection			
42.	Chemical exposure			Have local DMG H&S representative assist you in proper selection
43.	Using chainsaw, cutting brush			Chainsaw chaps

I certify that the above inspection was performed to the best of my knowledge and ability, based on the hazards present on _____.

_____
Signature

FIELD FIRST AID KIT SUPPLY LIST

Portable, plastic or metal, water resistance first aid kit, with handle

Bloodborne pathogens personal protective equipment kit (minimum requirements are latex gloves and CPR shield)

First aid manual

Ace bandage 3"

Assorted band aids

Sterile gauze pads 4" x 4"

Sterile non-stick gauze pads 2" x 3"

Paper tape (hypo-allergenic)

Burn ointment (for minor burns, use after cold water soak)

Antibiotic ointment (Neosporin or generic)

Alcohol prep pads

Iodine prep pads (if not allergic to iodine, use after soap and water wash for bloodborne exposure)

Ice pack

Gauze roll 2"

Butterfly strips (wound closure)

Tweezers (one use, disposable)

Temperature strips

Flashlight

Triangular bandage

Bandage scissors

Sterile normal saline eye wash, 4 ounce bottle

Ammonia inhalant ampoules

Insect sting relief wipes or spray

URS	Health and Safety Program **INCIDENT REPORT FORM**	Attachment 49-1 Revision 2: May 2004

ADMINISTRATIVE INFORMATION:

URS Division/Company: _____

Project or Office: _____

Project Number: _____

Date/Time of Incident: _____ _____

Location/Client Name: _____ _____

TYPE OF INCIDENT (Check all applicable items)			
☐ Illness	☐ Injury	☐ Fire, Explosion, Flash	☐ Unexpected Exposure
☐ Property Damage	☐ Vehicular Accident	☐ Other (describe):	

FOR INJURIES/ILLNESS ONLY	
Name of Injured Employee _____	Phone No. _____
Describe Injury _____	
Medical Treatment / First Aid _____	

EMPLOYEES' DESCRIPTION OF INCIDENT: (Describe the facts contributing to the incident. Identify individuals involved, witnesses, and their affiliations. Attach additional sheets, drawings, or photographs as needed.)

_____

_____

_____

_____

_____

_____

_____

_____

Employee Name _____

Employee Signature _____ Date _____

URS	Health and Safety Program **INCIDENT REPORT FORM**	Attachment 49-1 Revision 2: May 2004

SUPERVISORS' DESCRIPTION OF INCIDENT: (Provide any additional/different details than provided by employee. Attach additional sheets, drawings, or photographs as needed.) Use additional sheets if necessary.

_____

_____

_____

_____

_____

CORRECTIVE ACTIONS (*For Internal Use Only*):

_____

_____

_____

_____

_____

REVIEWED BY:

Supervisor or Project Manager _____ Date _____

Office Manager _____ Date _____

Health and Safety Representative _____ Date _____

Supervisor must deliver this report to the office or project health and safety representative within 24 hours of the reported incident.

DISTRIBUTION: The Office or Project Health and Safety Representative distributes to:

- Office Manager
- Project Manager
- Project / Office file
- Regional Health and Safety Manager
- URS Occupational Health Nurses

  Fax: 512.419.6413
  URS Phone: 866.326.7321
  EG&G Phone: 866.344.1415

(For URS Asia/Pacific and Europe Operations – distribute this form in accordance with the directions in SMS 49.)

Note: The Regional Health and Safety Manager will distribute this Incident Report to other appropriate URS line managers as appropriate.

(For Safety Staff only)	REPORT NO.	EROC CODE G0	**UNITED STATES ARMY CORPS OF ENGINEERS ACCIDENT INVESTIGATION REPORT** *(For Use of this Form See Attached Instructions and USACE Suppl to AR 385-40)*	**REQUIREMENT CONTROL SYMBOL: CEEC-S-8(R2)**

1. ACCIDENT CLASSIFICATION

PERSONNEL CLASSIFICATION	INJURY/ILLNESS/FATAL	PROPERTY DAMAGE	MOTOR VEHICLE INVOLVED	DIVING
GOVERNMENT ☐ CIVILIAN ☐ MILITARY	☐	☐ FIRE INVOLVED ☐ OTHER	☐	☐
☐ CONTRACTOR	☐	☐ FIRE INVOLVED ☐ OTHER	☐	☐
☐ PUBLIC	☐ FATAL ☐ OTHER		☐	

2. PERSONAL DATA

a. Name *(Last, First, MI)*	b. AGE	c. SEX ☐ MALE ☐ FEMALE	d. SOCIAL SECURITY NUMBER	e. GRADE

f. JOB SERIES/TITLE	g. DUTY STATUS	h. EMPLOYMENT STATUS AT TIME OF ACCIDENT
	☐ ON DUTY ☐ TDY ☐ OFF DUTY	☐ ARMY ACTIVE ☐ ARMY RESERVE ☐ VOLUNTEER ☐ PERMANENT ☐ FOREIGN NATIONAL ☐ SEASONAL ☐ TEMPORARY ☐ STUDENT ☐ OTHER *(Specify)*

3. GENERAL INFORMATION

a. DATE OF ACCIDENT *(month/day/year)*	b. TIME OF ACCIDENT *(Military time)* hrs	c. EXACT LOCATION OF ACCIDENT	d. CONTRACTOR's NAME (1) PRIME: (2) SUBCONTRACTOR:

e. CONTRACT NUMBER	f. TYPE OF CONTRACT	g. HAZARDOUS/TOXIC WASTE ACTIVITY
☐ CIVIL WORKS ☐ MILITARY ☐ OTHER *(SPECIFY)*	☐ CONSTRUCTION ☐ SERVICE ☐ A/E ☐ DREDGE ☐ OTHER *(SPECIFY)*	☐ SUPERFUND ☐ DERP ☐ IRP ☐ OTHER *(Specify)*

4. CONSTRUCTION ACTIVITIES ONLY *(Fill in line and corresponding code number in box from list - see instructions)*

a. CONSTRUCTION ACTIVITY	(CODE) #	b. TYPE OF CONSTRUCTION EQUIPMENT	(CODE) #

5. INJURY/ILLNESS INFORMATION *(Include name on line and corresponding code number in box for items e, f & g - see instructions)*

a. SEVERITY OF ILLNESS / INJURY	(CODE) #	B. ESTIMATED DAYS LOST	C. ESTIMATED DAYS HOSPITALIZED	D. ESTIMATED DAYS RESTRICTED DUTY

e. BODY PART AFFECTED	(CODE) #	g. TYPE AND SOURCE OF INJURY/ILLNESS	(CODE) #
PRIMARY		TYPE	
SECONDARY		SOURCE	
f. NATURE OF ILLNESS / INJURY			

6. PUBLIC FATALITY *(Fill in line and correspondence code number in box - see instructions)*

a. ACTIVITY AT TIME OF ACCIDENT	(CODE) #	b. PERSONAL FLOATATION DEVICE USED? ☐ YES ☐ NO ☐ N/A

7. MOTOR VEHICLE ACCIDENT

a. TYPE OF VEHICLE	b. TYPE OF COLLISION	c. SEAT BELTS	USED	NOT USED	NOT AVAILABLE
☐ PICKUP/VAN ☐ AUTOMOBILE ☐ TRUCK ☐ OTHER *(Specify)*	☐ SIDE SWIPE ☐ HEAD ON ☐ REAR END ☐ BROADSIDE ☐ ROLL OVER ☐ BACKING ☐ OTHER *(Specify)*	(1) FRONT SEAT			
		(2) REAR SEAT			

8. PROPERTY/MATERIAL INVOLVED

a. NAME OF ITEM	B. OWNERSHIP	C. $ AMOUNT OF DAMAGE
(1)		
(2)		
(3)		

9. VESSEL/FLOATING PLANT ACCIDENT *(Fill in line and correspondence code number in box from list - see instructions)*

a. TYPE OF VESSEL/FLOATING PLANT	(CODE) #	b. TYPE OF COLLISION/MISHAP	(CODE) #

10. ACCIDENT DESCRIPTION *(Use additional paper, if necessary)*

See attached page.

11. CAUSAL FACTOR(S) *(Read Instruction Before Completing)*

a. (Explain YES answers in item 13) YES NO

- DESIGN: Was design of facility, workplace or equipment a factor? ☐ ☐
- INSPECTION/MAINTENANCE: Were inspection & maintenance procedures a factor? ☐ ☐
- PERSON'S PHYSICAL CONDITION: In your opinion, was the physical condition of the person a factor? ☐ ☐
- OPERATING PROCEDURES: Were operating procedures a factor? ☐ ☐
- JOB PRACTICES: Were any job safety/health practices not followed when the accident occurred? ☐ ☐
- HUMAN FACTORS: Did any human factors such as size or strength of person, etc., contribute to accident? ☐ ☐
- ENVIRONMENTAL FACTORS: Did heat, cold, dust, sun, glare, etc., contribute to the accident? ☐ ☐

a. (CONTINUED) YES NO

- CHEMICAL AND PHYSICAL AGENT FACTORS: Did exposure to chemical agents, such as dust, fumes, mists, vapors or physical agents, such as, noise, radiation, etc., contribute to accident? ☐ ☐
- OFFICE FACTORS: Did office setting such as, lifting office furniture, carrying, stooping, etc., contribute to the accident? ☐ ☐
- SUPPORT FACTORS: Were inappropriate tools/resources provided to properly perform the activity/task? ☐ ☐
- PERSONAL PROTECTIVE EQUIPMENT: Did the improper selection, use or maintenance of personal protective equipment contribute to the accident? ☐ ☐
- DRUGS/ALCOHOL: In your opinion, was drugs or alcohol a factor to the accident ☐ ☐

b. WAS A WRITTEN JOB/ACTIVITY HAZARD ANALYSIS COMPLETED FOR TASK BEING PERFORMED AT TIME OF ACCIDENT?

☐ YES *(If yes, attach a copy.)* ☐ NO

12. TRAINING

a. WAS PERSON TRAINED TO PERFORM ACTIVITY/TASK?	b. TYPE OF TRAINING.	c. DATE OF MOST RECENT FORMAL TRAINING.
☐ YES ☐ NO	☐ CLASSROOM ☐ ON JOB	(Month) (Day) (Year)

13. FULLY EXPLAIN WHAT ALLOWED OR CAUSED THE ACCIDENT; INCLUDE DIRECT AND INDIRECT CAUSES *(See instruction for definition of direct and indirect causes.) (Use additional paper, if necessary)*

a. DIRECT CAUSE

See attached page.

b. INDIRECT CAUSE(S)

See attached page.

14. ACTION(S) TAKEN, ANTICIPATED OR RECOMMENDED TO ELIMINATE CAUSE(S).

DESCRIBE FULLY:

See attached page.

15. DATES FOR ACTIONS IDENTIFIED IN BLOCK 14.

a. BEGINNING (Month/Day/Year)	b. ANTICIPATED COMPLETION (Month/Day/Year)

c. SIGNATURE AND TITLE OF SUPERVISOR COMPLETING REPORT	d. DATE *(Mo/Da/Yr)*	e. ORGANIZATION IDENTIFIER *(Div, Br, Sect)*	f. OFFICE SYMBOL
CORPS _____ CONTRACTOR _____			

16. MANAGEMENT REVIEW *(1st).*

a. ☐ CONCUR b. ☐ NON CONCUR c. COMMENTS

SIGNATURE	TITLE	DATE

17. MANAGEMENT REVIEW *(2nd - Chief Operations, Construction, Engineering, etc.)*

a. ☐ CONCUR b. ☐ NON CONCUR c. COMMENTS

SIGNATURE	TITLE	DATE

18. SAFETY AND OCCUPATIONAL HEALTH OFFICE REVIEW

a. ☐ CONCUR b. ☐ NON CONCUR c. ADDITIONAL ACTIONS/COMMENTS

SIGNATURE	TITLE	DATE

19. COMMAND APPROVAL

COMMENTS

COMMANDER SIGNATURE	DATE

*U.S. GOVERNMENT PRINTING OFFICE: 1993-0-791-757

10.	ACCIDENT DESCRIPTION (Continuation)

13a.	DIRECT CAUSE *(Continuation)*

13b.	INDIRECT CAUSES *(Continuation)*

14.	ACTION(S) TAKEN, ANTICIPATED, OR RECOMMENDED TO ELIMINATE CAUSE(S) (Continuation)

ATTACHMENT C

Chemical Information Table

Chemical Information Table for Suspect Contaminants of Concern

Chemical Name Synonyms (trade name) (CAS No.)	Exposure Limits	Characteristics	Route of Exposure	Symptoms of Exposure
Pesticides/Herbicides				
Chlordane	PEL: 0.5 mg/m^3 REL: 0.5 mg/m^3 TLV: 0.5 mg/m^3 STEL: N/A IDLH: 100 mg/m^3(CA) Skin Yes	Amber colored, viscous liquid with a pungent, chlorine-like odor.	INH ABS CON ING	Blurred vision; confusion; ataxia, delirium; cough; abdominal pain, nausea, vomiting, diarrhea; irritability, tremor, convulsions.
Malathion	PEL: 15 mg/m^3 REL: 10 mg/m^3 TLV: 1.0 mg/m^3 (inhalable aerosol and vapor) STEL: N/A IDLH: 250 mg/m^3 Skin Yes	Deep brown to yeallow liquid with a garlic-like odor.	INH ABS CON ING	Irritated eyes, skin; aching eyes, blurred vision, lacrimation; salivation; anorexia, nausea, vomiting, abdominal cramps, diarrhea, dizziness, confusion; rhinitis, headache; chest tightness, wheezing.
DDT (50-29-3)	PEL: 1 mg/m^3 REL: 0.5 mg/m^3 TLV: 1 mg/m^3 STEL: N/A IDLH: 500 mg/m^3(CA) Skin: Yes	Colorless crystals or off-white powder with a slight, aromatic odor	INH ABS CON ING	Symptoms include irritation of eyes, skin; parasthesia of the tongue, lips, face, hands; tremor; dizziness, confusion, malaise, headache, fatigue, convulsions, vomiting. Carcinogen.
Diazinon®	PEL: none REL: 0.1 mg/m^3 (skin) TLV: 0.01 mg/m^3 (inhalable vapor and aerosol) STEL: N/A IDLH: N/A Skin: Yes	Colorless liquid with a faint ester-like odor.	INH ABS CON ING	Symptoms include irritated eyes, blurred vision; dizziness, confusion, lassitude, convulsions; dyspnea; salivation, abdominal cramps, nausea, vomiting.

Chemical Name Synonyms (trade name) (CAS No.)	Exposure Limits	Characteristics	Route of Exposure	Symptoms of Exposure
2,4-D (94-75-7	PEL: 10 mg/m^3 REL: 10 mg/m^3 TLV: 10 mg/m^3 STEL: N/A IDLH: 100 mg/m^3(CA) Skin No	White to yellow, crystalline, odorless powder (herbicide)	INH ABS CON ING	Lassitude, stupor, hyporeflexia, muscular twitch; convulsions; dermatitis
2,4,5-T	PEL: 10 mg/m^3 REL: 10 mg/m^3 TLV: 10 mg/m^3 STEL: N/A IDLH: 250 mg/m^3 Skin No	Colorless to tan, odorless, crystanlline solid	INH CON ING	In animals: ataxia; skin irritation, acne-like rash; liver damage
Dieldrin	PEL: 0.25 mg/m^3 REL: 0.25 mg/m^3 TLV: 0.25 mg/m^3 STEL: N/A IDLH: 50 mg/m^3(CA) Skin No	Colorless to light tan crystals with a mild, chemical odor.	INH ABS CON ING	Headache, dizziness; nausea, vomiting, malaise, sweating; myoclonic limb jerks; convulsions; coma.
Heptachlor	PEL: 0.5 mg/m^3 REL: 0.5 mg/m^3 TLV: 0.05 mg/m^3 STEL: N/A IDLH: 35 mg/m^3(CA) Skin No	White to light tan crystals with a camphor-like odor.	INH ABS CON ING	In animals: tremor, convulsions; liver damage.
Pentachlorophenol	PEL: 0.5 mg/m^3 REL: 0.5 mg/m^3 TLV: 0.5 mg/m^3 STEL: N/A IDLH: 2.5 mg/m^3 Skin No	Colorless to white, crystalline solid with a benzene-like odor.	INH ABS CON ING	Irritated eyes, nose, throat; sneezing, cough; lassitude, anorexia; sweating; headache, dizziness; nausea, vomiting; dyspnea, chest pain; high fever; dermatitis.
Metals				
Mercury (Inorganic and metallic) (7439-97-6)	PEL: 0.1 mg/m^3(C) REL: Vapor 0.05 mg/m^3 Other 0.1 mg/m^3 (C) TLV: 0.025 mg/m^3 STEL: 0.03 mg/m^3 IDLH: 10 mg/m^3 Skin: Yes	Silvery-white, heavy, odorless liquid. Appearance and odor vary depending on specific compound. Air odor threshold: N/A VP: 0.0012 mm	INH ABS CON ING	Highly toxic by skin absorption and inhalation of fume or vapor. Symptoms include irritated eyes and skin, cough, chest pain, headache, gastrointestinal distress, insomnia, bronchitis, stomatitis and pneumonitis.

Chemical Name Synonyms (trade name) (CAS No.)	Exposure Limits	Characteristics	Route of Exposure	Symptoms of Exposure
Arsenic (inorganic) (7440-38-2)	PEL: 0.01 mg/m^3 REL: None TLV: 0.01 mg/m^3 STEL: N/A IDLH: 5 mg/m^3(CA) Skin: No	Silvery-gray or tin-white brittle, odorless solid. Air odor threshold: N/D.	INH ABS CON ING	Symptoms include ulceration of nasal septum, gastrointestinal disturbances, respiratory irritation, and peripheral neuropathy. Potential occupational carcinogen.
Chromium (Metal) (7440-47-3)	PEL: 1.0 mg/m^3 REL: 0.5 mg/m3 TLV: 0.5 mg/m^3 STEL: N/A IDLH: 250 mg/m^3 Skin: No	Blue-white to steel-gray lustrous, brittle, hard odorless solid. Air odor threshold: N/D	INH ING CON	Symptoms may include irritated eyes and skin; lung fibrosis.
Chromium (Chromium III compounds)	PEL: 0.5 mg/m^3 REL: 0.5 mg/m3 TLV: 0.5 mg/m^3 STEL: N/A IDLH: 25 mg/m^3 Skin: No	Varies depending on specific compound	INH ING CON	Irritation of eyes; sensitivity dermatitis

NOTES:

OSHA PEL	Occupational Safety and Health Administration Final Rule Limits, Permissible Exposure Limit for an eight-hour, time-weighted average
ACGIH TLV	American Conference of Governmental Industrial Hygienists, Threshold Limit Value for an eight-hour, time-weighted average
STEL	Short-term Exposure Limit for a 15-minute, time-weighted average
NIOSH IDLH	National Institute for Occupational Safety and Health, Immediately Dangerous to Life or Health concentration
ppm	Part of vapor or gas per million parts of air by volume at 25° Celsius and 760 mm Hg
mg/m^3	Milligram of substance per cubic meter of air
µg/m^3	Microgram of substance per cubic meter of air
CAS	The Chemical Abstracts Service registry number is a numeric designation assigned by the American Chemical Society's Chemical Abstracts Service and uniquely identifies a specific chemical compound. This entry allows one to conclusively identify a substance regardless of the name or naming system used.
CA	NIOSH has identified numerous chemicals that it recommends be treated as potential or confirmed human carcinogens.
(C)	The (ceiling) concentration that should not be exceeded during any part of the working exposure.
Skin	Refers to the potential contribution to the overall exposure by the cutaneous (absorption) route, including mucous membranes and eye, either by airborne or, more particularly, by direct contact with the substance.
UEL	Upper Explosive Limit—the highest concentration of a material in air that produces an explosion in fire or ignites when it contacts an ignition source. A higher concentration of the material in a smaller percentage or concentration of air may be too rich to be ignited.

LEL	Lower Explosive Limit—the lowest concentration of the material in air that can be detonated by spark, shock, fire, etc.
INH	Inhalation
ABS	Skin absorption
ING	Ingestion
CON	Skin and/or eye contact

ATTACHMENT D

URS Safety Management Standards

URS SAFETY MANAGEMENT STANDARD
Worker Right-to-Know (Hazard Communication)

1. Applicability

This procedure applies to URS office and field operations.

2. Purpose and Scope

The worker right-to-know program provides URS personnel with information and training about safety and health hazards associated with the chemicals they might encounter in the workplace. This procedure describes how chemical safety hazards are communicated to URS personnel working in offices and at field site locations, and how information is to be provided to employees of other employers working at the location. The requirements include steps to acquire this information, maintain it, and train everyone to use it.

3. Implementation

Office Locations: Implementation of this program is the responsibility of the Office Manager.

Field Activities: Implementation of this program is the responsibility of the Project Manager.

4. Requirements

A. Hazardous Material Inventory

1. Maintain a hazardous material inventory that lists all of the hazardous materials used at each workplace (i.e., office/field location). Use chemical names consistent with the applicable material safety data sheet (MSDS).

2. File a copy of the chemical inventory with the Project Safety Plan or with the local URS Health, Safety, and Environment (HSE) Representative.

B. Material Safety Data Sheets (MSDS)

1. Obtain a MSDS for each chemical before it is used.

2. Review each MSDS when it is received to evaluate whether the information is complete and to determine if existing protective measures are adequate.

3. Maintain a collection of all applicable and relevant MSDS where they are accessible by all employees at all times.

4. Replace MSDS when updated sheets are received. Communicate any significant changes to those who work with the chemical.

5. MSDS are required for all hazardous materials used on site by project personnel.

C. Labels

Unless each container has appropriate labeling, label all chemical containers with:

1. Identity of the hazardous chemical(s),

2. Appropriate hazard warnings, and

3. Name and address of the chemical manufacturer, importer, or other responsible party.

D. Hazardous Nonroutine Tasks

Periodically, employees are required to perform hazardous non-routine tasks. Prior to starting work on such projects, provide each employee with information about hazards to which they may be exposed during such an activity.

This information will include:

1. Specific chemical hazards.

2. Protective/safety measures which must be utilized; and

3. Measures that have been taken to lessen the hazards including ventilation, respirators, presence of another employee and emergency procedures.

E. Informing Contractors/Subcontractors

Provide contractors/subcontractors the following information on chemicals used by or provided to URS personnel:

1. Names of hazardous chemicals to which they may be exposed while on the jobsite.

2. Precautions the employees may take to lessen the possibility of exposure by usage of appropriate protective measures.

3. Location of URS MSDS and written chemical inventory.

F. Training

1. Conduct training of all employees potentially exposed to hazardous materials on the following schedule:

   a. Before new employees begin their jobs.

   b. Whenever new chemicals are introduced into the workplace, or

   c. Annually thereafter.

2. This training will include:

   a. Applicable regulatory requirements.

   b. Names of those responsible for implementing this program.

   c. Location of the program, inventory and MSDS.

   d. Chemicals used and their hazards (chemical, physical and health).

   e. How to detect the presence or release of chemicals.

   f. Safe work practices.

   g. How to read an MSDS.

3. Document the training.

5. Documentation Summary

A. File these records with the local URS HSE Representative:

1. Chemical Inventory.

2. Location of the MSDS inventory.

3. Training records.

4. Contractor/Subcontractor notifications.

B. File these records in the Project Safety File.

1. Chemical Inventory.
2. Location of the MSDS inventory.
3. Training records.
4. Contractor/Subcontractor notifications.

6. Resources

A. U.S. OSHA Technical Links - Hazard Communication

B. U.K. - Control of Substance Hazardous to Health - Regulations

References to the UK legislation listed above can be found at the link provided:

www.tionestop.com
username: Thorburn
password: Dames
enter search criteria – (see underlined text)
select the checkbox for Construction Information Service (CIS)

C. National Paint and Coatings Association (NPCA) Hazardous Materials Identification System (HMIS) Version III

D. National Fire Protection Association (NFPA) Standard 704 (Standard System for the Identification of Hazardous Materials for Emergency Response)

URS SAFETY MANAGEMENT STANDARD
Emergency Action Plans

1. Applicability

This procedure applies to URS office and field operations.

2. Purpose and Scope

This procedure establishes policy, assigns responsibilities, and provides guidance to URS offices/field projects regarding emergency action. It includes general information on actions to be taken by URS management and employees in the event of a fire or other emergency that may endanger life or property.

The objectives of this procedure are to:

A. Promote a fast, effective reaction in coping with emergencies.

B. Save lives and avoid injuries and panic.

C. Restore order and conditions back to normal levels with a minimum of confusion and as promptly as possible.

3. Implementation

Office Locations- Implementation of this program is the responsibility of the Office Manager.

Field Activities- Implementation of this program is the responsibility of the Project Manager.

4. Requirements

A. Emergency Action Plan Development

1. Gather Information

Each URS office/project must develop an Emergency Action Plan (EAP) tailored to its specific situation. Office Managers will check with their building manager or landlord regarding evacuation procedures they may have in place and incorporate these procedures into the EAP. Project EAPs must comply with client requirements and specifications. The EAP must contain the following:

a. Reporting Fires and Other Emergencies

Describe the procedures that personnel should follow to report emergencies. List emergency telephone numbers for fire, paramedics and police. Include local prefixes on emergency numbers, if required, such as 9-911.

b. Alarm System

Describe the emergency alarm system for the building/site as applicable. Include the description and location of fire alarm pull boxes and visual and audible alarms. If a public address (PA) system is used to notify occupants of emergencies, include the procedures to activate the PA system, such as calling the receptionist or building manager's office, and a description of the announcements that will be made.

c. Evacuation Routes and Procedures

Develop a map or description of the evacuation routes and emergency exits to be use. A description of the building emergency lighting system, exit signs, and available fire suppression systems may also be included. Evacuation route maps may be posted in the offices. There should be a primary and alternate evacuation route and exit from each work area.

Describe procedures regarding the use of elevators, if applicable. In most cases elevator use is prohibited during an emergency. The building manager should be consulted for these procedures.

Include procedures to determine that no employees have been inadvertently left behind.

d. Critical Equipment/Operations Procedures

Designate personnel responsible for shutting down critical equipment and the procedures for doing so, if applicable.

e. Assisting Disabled Personnel

Describe the provisions that have been made for notifying and assisting personnel with disabilities during an emergency. Such provisions are to accommodate personnel in wheelchairs, those who are temporarily disabled (such as

personnel on crutches) or those with impaired vision or hearing.

f. Personnel Accounting Procedures

Designate a primary and alternate assembly area for personnel who are evacuating. Require sufficient distance so that personnel will not be exposed to fire, debris, or traffic, nor interfere with emergency responders.

Designate an individual and an alternate with the assigned responsibility for taking a headcount in the assembly area and reporting missing personnel to emergency responders.

Define the procedures on how employees will be informed that it is safe to re-enter the building or to leave for home.

g. Rescue and Medical Duties

Include the statement that "URS does not expect or encourage its employees to engage in firefighting, medical treatment, rescue, or other emergency response. Such activities should only be performed by properly equipped and trained emergency responders. URS recognizes that some of its personnel may have received training in first aid and cardiopulmonary resuscitation (CPR) and may wish to perform these duties on injured personnel."

Require that no employees leave the facility until all re accounted for.

2. Develop Emergency Action Plans based on the information gathered as described above.

B. Posting

1. Post the Emergency Action Plan where it is available to all site employees.

2. Post evacuation maps at all exits and points of egress.

C. Training

Train all employees regarding the requirements of the Emergency Action Plan.

5. Documentation Summary

A. Office

File these records in the Office Safety Filing System:

1. Emergency Action Plan
2. Evacuation Maps
3. Training records

B. Field

File these records in the Project Safety File.

1. Emergency Action Plan
2. Evacuation Maps
3. Training records

6. References

A. U.S. OSHA Standard - Emergency Action Plans - 29 CFR 1910.38

B. U.S. OSHA – Emergency Exit Routes Fact Sheet

URS SAFETY MANAGEMENT STANDARD
Electrical Safety

1. Applicability

This program applies to URS field operations in North American where electricity is used, electrical systems are installed or maintained, or where live electrical circuits are accessed. For work around overhead or underground utilities, see SMS 34, "Utility Clearances".

2. Purpose and Scope

This procedure describes requirements for working on electrical circuits with voltage greater than 50 volts. The primary hazards related to electricity are shock, burns, arc-blast, fire and explosions. This procedure is intended to reduce worker risk to electrical hazards.

3. Implementation

Office Locations - Implementation of this program is the responsibility of the Office Manager.

Field Activities - Implementation of this program is the responsibility of the Project Manager.

4. Requirements

A. Any work performed on live electrical systems must be done by a licensed or journeyman electrician.

B. Follow established lockout/tagout procedures. Refer to SMS 23, "Lockout and Tagout Safety".

1. Consider all electrical systems as live until verified de-energized and grounded.

2. Do not work on or in close proximity to electrical circuits unless the circuit is de-energized, grounded or guarded.

C. Hazardous Locations

Determine if electric equipment and wiring will be installed in locations that are classified depending on:

1. The properties of flammable vapors, liquids or gases, or combustible dusts or fibers that may be present; as well as the likelihood that a flammable or combustible concentration or quantity

is present. Refer to Attachment 12-1 for definitions of hazardous locations.

2. Consult Resources A, B, F, and G for information on working in classified locations.

D. Ground Fault Circuit Interrupters and Grounding

1. Ground Fault Circuit Interrupters

   a. Provide approved ground-fault circuit interrupters for all 120-volt, single phase, 15- and 20-ampere receptacle outlets on construction sites.

   b. Provide ground-fault circuit interrupters for all 120-volt, single phase, 15-and 20-ampere receptacle outlets within garages, bathrooms, kitchens and shops.

2. Grounding/Earthing

   Effectively ground all wiring, electrical circuits, and equipment, except portable tools & appliances protected by an UL-approved system of double insulation. Examples of equipment requiring grounding include:

   a. Portable and vehicle or trailer mounted generators.

   b. Electrically powered arc welders.

   c. Switches.

   d. Motor controller cases.

   e. Fuse boxes.

   f. Distribution cabinets.

   g. Frames.

   h. Non-current-carrying rails used for travel and motors of electrically operated cranes.

   i. Electric elevators.

j. Metal frames of non-electric elevators to which electric conductors are attached.

E. Circuits

1. Require that there are no missing blanks.

2. Close doors to circuit and fuse boxes when not in use.

3. Label every circuit located on a circuit breaker/fuse box and/or motor control center (MCC).

F. Temporary Wiring, Electrical Tools and Extension Cords

1. Require that temporary wiring is installed and used in accordance with references. Specifically:

   a. Guard, bury or isolate by elevation temporary wiring to prevent accidental contact by workers and equipment.

   b. Require that vertical clearance above walkways is not less than 10 feet (3 metres) from circuits carrying 600 volts or less.

   c. Support all exposed temporary wiring on insulators.

   d. Protect temporary wiring from accidental damage.

   e. Guard live parts of wiring.

   f. Mark temporary power lines, switch boxes, receptacle boxes, metal cabinets and enclosures around equipment to indicate the maximum operating voltage.

2. Require that lighting strings are installed and used in accordance with Resources A and B. Specifically:

   a. Use nonconductive lamp sockets and connections permanently molded to the conductor insulation.

   b. Require that lighting strings have lamp guards.

   c. Replace all broken or defective bulbs promptly.

d. Protect all lights used for illumination from accidental contact or breakage.

e. Ground metal-case sockets.

3. Require that extension cords are installed and used in accordance with Resources A and B. Specifically:

   a. Use only 3-wire grounded type extension cords designated for hard service or extra hard service and listed by Underwriters Laboratories, Inc.

   b. Check cords for damage before use.

   c. Do not exceed the rated load.

   d. Do not use spliced cords.

   e. Destroy and discard worn or frayed cords.

   f. Do not fasten extension cords with staples, hang them by nails or suspend them by wire.

   g. Do not wrap cords or cables around any conductive materials.

4. Require that portable electric tools brought onto the site are in good condition. Before use on any shift, visually inspect portable cord and plug connected equipment for external defects and evidence of possible internal damage.

G. Report to supervision potential electrical hazards or unexpected occurrences while electrical renovation or construction occurs.

H. Keep accurate records of all pertinent work performed on a project.

   1. Keep as-built designs updated.

   2. Share information on modifications with contractors on site.

I. Isolation of live electrical components

Isolate all live, unprotected electrical components through the use of barricades, fencing or other means to protect employees from contact.

J. Briefing

1. Brief workers on electrical hazards at the beginning of the job. Utilize Attachment 12-2 as a guide for proper PPE as applicable.

2. Brief new workers entering the site.

3. Brief workers when electrical conditions change or when hazards exist.

K. Inspection

Inspect the job site periodically using Attachment 12-3 to evaluate compliance with this standard.

5. Documentation Summary

Project Safety Files

A. Licensed/journeyman electrician for project (as necessary).

B. Attachment 12-3,"Audits."

C. Documented communications between URS, contractors, licensed/journeyman electricians, or others.

6. Resources

A. U.S. OSHA Standard - General Industry Electrical Safety - 29 CFR 1910, Subpart S

B. U.S. OSHA Standard - Construction Electrical Safety - 29 CFR 1926, Subpart K

C. U.S. OSHA Standard - Design Safety Standards for Electrical Systems - 29 CFR 1910, Subpart S

D. U.S. OSHA Standard - The Control of Hazardous Energy (Lockout/Tagout) - 29 CFR 1910.147

E. Australian Standards SAA HB94-1997 - Electrical Safety in the Workplace

F. American National Standards Institute/Institute of Electrical and Electronics Engineers - National Electrical Safety Code (NESC), ANSI/IEEE C2-2002

G. National Fire Protection Association, National Electric Code, NFPA-70

The following documents are PDF files requiring the use of Adobe Acrobat reader.

H. Attachment 12-1 - Hazardous Locations

I. Attachment 12-2 - PPE, Tools and Equipment

J. Attachment 12-3 - Electrical Hazard Check Sheet

HAZARDOUS LOCATIONS

"Class I Locations"

Class I locations are those in which flammable gases or vapors are or may be present in the air in quantities sufficient to produce explosive or ignitable mixtures. Class I locations include the following:

A. Class I, Division 1 location is a location:

1. In which ignitable concentrations of flammable gases or vapors may exist under normal operating conditions; or
2. In which ignitable concentrations of such gases or vapors may exist frequently because of repair or maintenance operations or because of leakage; or
3. In which breakdown or faulty operation of equipment or processes might release ignitable concentrations of flammable gases or vapors, and might also cause simultaneous failure of electric equipment.

B. Class I, Division 2 location is a location:

1. In which volatile flammable liquids or flammable gases are handled, processed, or used, but in which the hazardous liquids, vapors, or gases will normally be confined within closed containers or closed systems from which they can escape only in case of accidental rupture or breakdown of such containers or systems, or in case of abnormal operation of equipment; or
2. In which ignitable concentrations of gases or vapors are normally prevented by positive mechanical ventilation, and which might become hazardous through failure or abnormal operations of the ventilating equipment; or
3. That is adjacent to a Class I, Division 1 location, and to which ignitable concentrations of gases or vapors might occasionally be communicated unless such communication is prevented by adequate positive-pressure ventilation from a source of clean air, and effective safeguards against ventilation failure are provided.

"Class II Locations"

Class II locations are those that are hazardous because of the presence of combustible dust. Class II locations include the following:

A. Class II, Division 1 location is a location:

1. In which combustible dust is or may be in suspension in the air under normal operating conditions, in quantities sufficient to produce explosive or ignitable mixtures; or

2. Where mechanical failure or abnormal operation of machinery or equipment might cause such explosive or ignitable mixtures to be produced, and might also provide a source of ignition through simultaneous failure of electric equipment, operation of protection devices, or from other causes, or

3. In which combustible dusts of an electrically conductive nature may be present.

B. Class II, Division 2 location is a location in which:

1. Combustible dust will not normally be in suspension in the air in quantities sufficient to produce explosive or ignitable mixtures, and dust accumulations are normally insufficient to interfere with the normal operation of electrical equipment or other apparatus; or

2. Dust may be in suspension in the air as a result of infrequent malfunction of handling or processing equipment, and dust accumulations resulting therefrom may be ignitable by abnormal operation or failure of electrical equipment or other apparatus.

"Class III Locations"

Class III locations are those that are hazardous because of the presence of easily ignitable fibers or flyings but in which such fibers or flyings are not likely to be in suspension in the air in quantities sufficient to produce ignitable mixtures. Class III locations include the following:

A. Class III, Division 1 location is a location in which easily ignitable fibers or materials producing combustible flyings are handled, manufactured, or used.

B. Class III, Division 2 location is a location in which easily ignitable fibers are stored or handled, except in process of manufacture.

URS	Health, Safety, and Environment **PPE, TOOLS AND EQUIPMENT NEEDED DURING ELECTRICAL WORK**	Attachment 12-2 Revision 1: March 2005

If there is a danger of:	Then use the following:
Head injury from electric shock, or Burns due to contact with exposed energized parts	Nonconductive head protection – Class II nonconductive hard hat
Injury to the eyes or face from: Electric arcs or flashes; or Flying objectives resulting from electrical explosion	Protective equipment for the eyes and face – face shield and safety glasses
Shock to hands while handling energized wires	Lineman's rubber insulated gloves rated for the voltage exposed to. Leather overgloves may be needed if exposure to abrasive surfaces is possible.
Shock while working in areas where high voltage electrical systems are present, or Shock when performing electrical repairs	Non-conductive protective foot wear
Exposure to electric arcing or flashing from: Opening or closing 2400 volt oil cutout switching devices; Removing or installing links in high voltage able tap boxes; or Removing or installing fuses in high voltage circuits.	Protective coveralls made of Nomex or other suitable flash-proof material.

IF	THEN
Energized parts are exposed.	Use nonconductive ropes and handlines near the exposed energized part.
Working near exposed energized conductors or circuit parts.	Use insulated tools or handling equipment if the tools or handling equipment might make contact with such conducts or parts.
The insulating capability of insulated tools or handling equipment is subject to damage.	Protect the insulating material.
Removing or installing fuses when the fuse terminals are energized.	Use fuse-handling equipment insulated for the circuit voltage.
Working near exposed energized parts that might be accidentally contacted or where dangerous electric heating or arcing might occur.	Use protective shields, protective barriers, or insulating materials to protect from shock, burns, or other electrically related injuries.
Normally enclosed live parts are exposed for maintenance or repair.	Guard the parts to protect unqualified persons from contact with the live parts.

URS	Health, Safety, and Environment **ELECTRICAL HAZARD CHECKLIST**	Attachment 12-3 Revision 1: March 2005

Location Inspected: _____ **Job No.:** _____

Date Inspected: _____ **Name of Inspector:** _____

Check Yes, No or N/A for Not Applicable. If comment is required, circle the number and see Page 3.

		Yes	No	N/A
	Electrical Equipment Markings			
1.	Disconnecting switches and circuit breakers are labeled to indicate their use or equipment served.			
2.	The necessary voltage, wattage, or current ratings are labeled.			
3.	Circuit breakers clearly indicate whether they are in the "on" or "off" position.			
	Electrical Grounding			
4.	Extension cords used have a grounding conductor (third plug).			
5.	Ground fault circuit interrupters are installed as required.			
6.	Portable electrical tools and equipment are of the double insulated type.			
7.	Ground fault circuit interrupters open the circuit on a ground current of 5 milliamperes or greater and are equipped with an integral push button test circuit.			
8.	Ground fault circuit interrupters are installed in accordance with the manufacturer's instructions.			
9.	Ground fault circuit interrupters are tested prior to initial use and periodically thereafter.			
10.	Grounding rods are at least 5/8-inch diameter steel or iron rods, ½-inch diameter copper clad steel, or ¾-inch diameter galvanized pipe.			
11.	Grounding rods are in eight-foot lengths and driven to full depth.			
	The path from circuits, equipment, structures, and conduits or enclosures to ground are:			
12.	• Permanent and continuous.			
13.	• Have ample carrying capacity for the current likely to be imposed on it.			
14.	• Have resistance sufficiently low to permit current flow to operate circuit breakers and similar overcurrent devices on the circuit.			
15.	Driven ground rod electrodes have a resistance to ground not exceeding 25 ohms.			
16.	Upon installation of the driven ground rod electrode, the resistance was tested and recorded.			
17.	Conductors, used for bonding and grounding circuits, are of sufficient size to carry the anticipated current.			
18.	Grounds are not removed until all work is complete.			

URS SAFETY MANAGEMENT STANDARD
Flammable and Combustible Liquids and Gases

1. Applicability

This procedure applies to URS office and field operations where flammable and combustible liquids and gases are stored or used.

2. Purpose and Scope

The purpose of this procedure is to provide information regarding the proper storage, handling and work practices associated with flammable and combustible liquids and gases.

3. Implementation

Office Locations- Implementation of this program is the responsibility of the Office Manager.

Field Activities- Implementation of this program is the responsibility of the Project Manager.

4. Requirements

A. Appoint a Responsible Person who will:

1. Inspect storage areas periodically.
2. Monitor the quantity of flammable and combustible liquids and gases on the site.
3. Review work practices.

B. Control flammables, combustibles, and flammable gases entering the site.

1. Order only those materials and quantities that are needed to complete a job.
2. Check compliance with SMS 2, "Worker Right to Know".

C. Storage

1. Store flammable and combustible materials in appropriate tanks and containers. See Attachment 15-1.
2. Limit building storage outside of a flammable storage cabinet or storage room per Attachment 15-1.

3. Store oxidizers separately from flammables.

4. Segregate gas cylinders for storage based on their hazard. Keep oxygen and acetylene cylinders stored separately.

D. Labeling and Signage

1. Post a "NO SMOKING OR OPEN FLAME" sign in all areas where flammable and combustible materials are stored, handled, and processed.

2. Require all containers and cylinders to be labeled with the contents and hazard-warning label per SMS 002.

E. Use of Materials on Site

1. Use flammable, combustible, and compressed gases in a manner that is consistent with the label and material safety data sheet for the product.

2. Use only those amounts of materials needed for the job. Transfer of flammables, combustibles, oxidizers to ready use containers is encouraged.

3. Use personal protective equipment stated on the product label and material safety data sheet.

F. Spill Control

1. Have a written spill response plan in place before materials are stored on site.

2. Clean up or respond to spills promptly.

G. Disposal

1. Keep solvent waste and flammable liquids in fire resistant, covered containers until they are removed from the worksite.

2. Do not place flammable or combustible waste in municipal garbage.

3. Dispose of flammable hazardous materials with a licensed hazardous material disposal company.

H. Inspection

1. Periodically inspect flammable and combustible storage and use areas, gas storage areas and oxidizer storage areas:

    a. Office settings inspect quarterly.

    b. Field-related projects inspect monthly.

2. Use the inspection sheet provided as Attachment 15-2 to inspect the storage areas.

I. Training

Require that Hazard Communication training includes specific hazard information for the flammables, combustibles and oxidizers used.

5. Documentation Summary

A. File these records in the Office Safety Filing System:

1. Location of the MSDS inventory.

2. Completed Flammable and Combustibles Inspection Checklist.

B. File these records in the Project Safety Filing System:

1. Attach program to Project Health and Safety or Safe Work Plan.

2. File these records in the Project Safety File.

    a. Location of the MSDS inventory

    b. Completed Flammable and Combustibles Inspection Checklist.

6. Resources

A. National Fire Protection Association - Standard 58

B. Regulations of the U.S. Coast Guard

C. U.S. OSHA Standard - Flammable and Combustible Liquids - 29 CFR 1910.106

D. U.K. "Dangerous Substances and Explosive Atmospheres Regulations 2002"

E. Australian Standards AS 1940-2004. The Storage and Handling of Flammable and Combustible Liquids

F. Attachment 15-1 - Flammable and Combustible Liquid Classifications

G. Attachment 15-2 - Flammable, Combustible, Oxidizer & Compressed Gas Inspection Sheet.

URS	Health, Safety and Environment **FLAMMABLE AND COMBUSTIBLE LIQUID CLASSIFICATIONS**	Attachment 15-1

Flammable Liquid	Flash Point	Boiling Point
Class 1A	< 73^0 F	< 100^0 F
Class 1B	< 73^0 F	> 100^0 F
Class 1C	> 73^0 F < 100^0 F	
Combustible Liquid		
Class 2	> 100^0 F < 140^0 F	
Class 3	140^0 F	

Maximum Allowable Size of Containers and Portable Tanks

	Flammable Liquids			Combustible Liquids	
Container Type	Class 1A	Class 1B	Class 1C	Class II	Class III
Glass or approved plastic	1 pt	1 qt	1 gal	1 gal	1 gal
Metal (other than DOT drums)	1 gal	5 gal	5 gal	5 gal	5 gal
Safety cans	2 gal	5 gal	5 gal	5 gal	5 gal
Metal drums (DOT specifications)	60	60	60	60	60
Approved portable tanks	660 gal	660 gal	660 gal	660 gal	660 gal

Maximum Storage in Buildings Outside of Storage Cabinet or Storage Room

Type	Amount
Class 1A	25 gallons
Class 1B (containerized)	120 gallons
Class 1B (single portable tank)	660 gallons
Class 1C (Containerized)	120 gallons
Class 1C (single portable tank)	660 gallons
Class 2 (containerized)	120 gallons

URS	Health, Safety, and Environment FLAMMABLE, COMBUSTIBLE, OXIDIZER & COMPRESSED GAS INSPECTION CHECKLIST	Attachment 15-2

Location Inspected: _____ **Job No.:** _____

Date Inspected: _____ **Name of Inspector:** _____

		Yes	No	N/A
	Storage Cabinets			
1.	Flammable cabinets do not obstruct room exits.			
2.	No more than 60 gallons of flammable or 120 gallons of combustible liquid is stored in a cabinet.			
3.	No more than three cabinets are located in a storage area.			
4.	Metal storage cabinets have self-closing doors.			
5.	Cabinets are labeled "FLAMMABLE-KEEP FIRE AWAY"			
	Safety Cans			
6.	Safety cans are constructed of stainless steel, Monel or tin.			
7.	Safety cans have a flame arrestor and spring-loaded cap on both the filling and pouring spouts.			
	Drum & Drum Storage Areas			
8.	Drums are stored in a vertical position.			
9.	Bungs are closed when liquid is not being transferred.			
10.	Drums are shielded from the sun.			
11.	Funnels with installed flash arrestor are used when transferring flammable liquids into drums.			
12.	A minimum distance of 25 feet between a drum storage area and buildings is present.			
13.	A "NO SMOKING" sign is posted in the area.			
14.	An emergency spill kit is near the drum storage area.			
15.	A 20 lb. dry-chemical fire extinguisher is no less than 10 feet or more than 50 feet from the storage area.			
	Waste Cans			
16.	Combustible scrap, debris and waste materials (oily rags, etc.) are stored in covered metal cans.			
17.	Waste cans are removed from the work area daily.			
18.	Waste cans have spring-loaded self-closing lids.			
	Storage Rooms Designed Specifically For Flammable Materials			
19.	Room construction meets NFPA fire-resistance requirements.			
20.	Rooms with automatic extinguishing systems have the following:			
	• Noncombustible liquid-tight raised sills or ramps at least four inches in			

URS SAFETY MANAGEMENT STANDARD
Hand Tools and Portable Equipment

1. Applicability

This procedure applies to URS operations involving the use of hand tools and/or power equipment, including chain saws, brush cutters, powder-actuated tools, and similar high-hazard implements.

2. Purpose and Scope

The purpose of this standard is to provide guidelines for the safe use and handling of hand tools and power equipment.

3. Implementation

Office/Facility Locations -	Implementation of this program is the responsibility of the Office Manager.
Field Locations -	Implementation of this program is the responsibility of the Project Manager.

4. Requirements

A. General

1. Keep hand and power tools in good repair and used only for the task for which they were designed.
2. Remove damaged or defective tools from service.
3. Keep surfaces and handles clean and free of excess oil to prevent slipping.
4. Do not carry sharp tools in pockets.
5. Clean tools and return to the toolbox or storage area upon completion of a job.
6. Wrenches must have a good bite before pressure is applied.
    a. Brace yourself by placing your body in the proper position so that that you will not fall in case the tool slips.
    b. Make sure hands and fingers have sufficient clearance in the event the tool slips.

c. Always pull on a wrench, never push.

7. When working with tools overhead, place tools in a holding receptacle or secure when not in use.

8. Do not throw tools from place to place, from person to person, or drop from heights.

9. Use non-sparking tools in atmospheres with fire or explosive characteristics.

10. Inspect all tools prior to start-up or use to identify any defects.

11. Powered hand tools should not be capable of being locked in the on position.

12. Require that all power fastening devices be equipped with a safety interlock capable of activation only when in contact with the work surface.

13. Do not allow loose clothing, long hair, loose jewelry, rings and chains to be worn while working with power tools.

14. Do not use cheater pipes.

15. Make provisions to prevent machines from automatically restarting upon restoration of power (see SMS 023).

B. Grinding Tools

1. Inspect work rests and tongue guards for grinders.

   a. Work rest gaps should not exceed 1/8 inch (3 mm).

   b. Tongue guards gap should not exceed ¼ inch (6 mm).

2. Do not adjust work or tool rests while the grinding wheel is moving.

3. Inspect the grinding wheel for cracks, chips or defects. Remove from service if any defects are found.

4. Wear goggles when grinding. A clear full face shield may be worn with the goggles.

5. Do not use the side of a grinding wheel unless the wheel is designed for side grinding.

6. Always stand to the side of the blade, never directly behind it.

7. Use grinding wheels only at their rated speed.

8. Grinding aluminum is prohibited.

9. For U.K. operations:

    a. No grinding wheels exceeding 55mm are to be used.

    b. All wheels are to be marked with their safe maximum speed.

    c. Abrasive wheels will only be operated by personnel who have been specifically trained and specified competent by URS.

    d. Abrasive wheels will only be operated by persons specified as competent, under the 'Abrasive Wheels" Regulations.

    e. Abrasive wheels must only be operated if the manufacturer's guard is fitted and they are in good working order.

C. Power Saws

1. Require that circular saws are fitted with blade guards.

2. Remove damaged, bent or cracked saw blades from service immediately.

3. Require that table saws are fitted with blade guards and a splitter to prevent the work from squeezing the blade and kicking back on the operator.

4. Require guards that cover the blade to the depth of the teeth on hand held circular saws. The guard should freely return to the fully closed position when withdrawn from the work surface.

D. Wood Working Machinery

1. Do not use compressed air to remove dust and chips from wood working machinery.

2. Locate the on-off switch to prevent accidental start up. The operator must be able to shut off the machine without leaving the work station.

3. Guard planers and joiners to prevent contact with the blades.

4. Use a push stick when:

   a. The cutting operation requires the hands of the operator to come close to the blade.

   b. Small pieces are being machined.

5. Adjust saw blades so they only clear the top of the cut.

6. Automatic feed devices should be used whenever feasible.

E. Pneumatic Tools and Equipment

1. Require that pneumatic tools have:

   a. Tool retainers to prevent the tool from being ejected from the barrel during use.

   b. Safety clips or tie wires to secure connections between tool/hose/compressor if they are of the quick connection (Chicago fittings) type.

2. Do not lay hose in walkways, on ladders or in any manner that presents a tripping hazard.

3. Never use compressed air to blow dirt from hands, face or clothing.

4. Compressed air exhausted through a chip guarded nozzle shall be reduced to less than 30 psi. Proper respiratory, hand, eye and ear protection must be worn.

5. Never raise or lower a tool by the air hose.

F. Powder Actuated Fastener Tools

1. Use powder actuated tools that comply with the requirements of the American National Standards Institute (ANSI)/American Society of Safety Engineers(ASSE) Standard A10.3 - 1995.

2. Use only individuals that have been trained by a manufacturer's representative and possess the proper license to operate, repair, service and handle powder actuated tools.

3. Never use a powder actuated tool in a flammable or explosive atmosphere.

4. Require the use of goggles or a full face shield as well as safety glasses during operation of powder actuated tools.

5. Powder actuated tools must not be able to be fired unless the tool is pressed against the work surface.

6. The tool must not be able to fire if the tool is dropped when loaded.

7. Firing the tool should require two separate operations, with the firing movement being separate from the motion of bringing the tool to the firing position.

8. Never fire into soft substrate where there is potential for the fastener to penetrate and pass through, creating a flying projectile hazard.

9. Do not use powder actuated tools in reinforced concrete if there is the possibility of striking the re-bar.

10. Do not use on cast iron, glazed tile, surface hardened steel, glass block, live rock or face brick.

11. Never load and leave a powder actuated tool unattended. It should only be loaded prior to intended firing.

12. Test tools each day prior to loading by testing safety devices according to manufacturer's recommended procedure.

G. Chain Saws

1. Inspect the saw prior to each use and periodically during daily use.
2. Operate the chain saw with both hands at all times.
3. Never cut above chest height.
4. Require that the idle is correctly adjusted on the chain saw. The chain should not move when the saw is in the idle mode.
5. Start cutting only after a clear escape path has been made.
6. Shut the saw off when carrying through brush or on slippery surfaces. The saw may be carried no more than 50 feet (15 meters) while idling.
7. Require applicable protective gear. This may include, but is not limited to:
    a. Logger's safety hat.
    b. Safety glasses.
    c. Steel-toed boots.
    d. Protective leggings.
    e. Hearing protection.
8. Inspect saws to require that they are fitted with an inertia break and hand guard.
9. *Never* operate a chain saw when fatigued.
10. Do not allow others in the area when chain saws are operated.
11. Make sure there are no nails, wire or other imbedded material that can cause flying particles.
12. Do not operate a chain saw that is damaged, improperly adjusted, or is not completely and securely assembled.

Always keep the teeth sharp and the chain tight. Worn chains should immediately be replaced.

13. Keep all parts of your body away from the saw chain when engine is running.

14. For U.K. operations, only personnel specifically trained and certified as competent by URS can operate chain saws.

H. Hand Operated Pressure Equipment

1. Pressure equipment such as grease guns, paint and garden sprayers shall be directed away from the body and other personnel in the area. The person operating any equipment such as this, which has a potential for eye injury, must wear protective goggles.

2. The noise produced when using certain types of pressure equipment may require the use of hearing protection.

3. Never allow the nozzle of a pressurized tool to come in contact with any body parts while operating. There is potential for injection of a chemical directly into the user's body, resulting in severe injury or death.

I. Gasoline Powered Tools

1. Never pour gasoline on hot surfaces.

2. Never fuel around open flame or while smoking.

3. Shut down the engine before fueling.

4. Provide adequate ventilation when using in enclosed spaces.

5. Use only OSHA approved safety cans to transport flammable liquids.

J. Inspection

Inspect all hand tools on a regular basis. Defective tools shall be immediately removed from service and tagged or destroyed to prevent further use.

5. Documentation Summary

Place in the Project Safety File:

A. Site briefings regarding tool use.

B. Records of tools removed from service.

C. Copies of powder actuated tool licenses (as applicable).

D. Tool inspection documentation.

6. Resources

A. U.S. OSHA Standard - Hand and Portable Power Tools - 29 CFR 1910, Subpart P

B. U.S. OSHA Standard - Construction Tools - Hand and Power - 29 CFR 1926, Subpart I

C. ANSI/ASSE A10.3 – 1995

D. National Association of Demolition Contractors

E. U.K. - 'Provision and Use of Work Equipment' Regulations 1998

F. Australia/New Zealand Standards – Powder-Actuated Handheld Fastening Tools - AS/NZS 1873.1:2003

G. Australian/New Zealand Standards – Hand-held Motor-operated Electric Tools – AS/NZS 60745.1:2003

URS SAFETY MANAGEMENT STANDARD
Heat Stress

1. Applicability

This procedure applies to URS field projects where ambient (not adjusted) temperatures exceed 70°F (21°C) for personnel wearing chemical protective clothing, including Tyvek coveralls, and 90°F (32°C) for personnel wearing normal work clothes.

2. Purpose and Scope

The purpose of this procedure is to protect project personnel from the effects of heat related illnesses.

3. Implementation

Field Activities - Implementation of this procedure is the responsibility of the Project Manager.

4. Requirements

A. Monitor ambient temperatures and conduct heat stress monitoring when threshold temperatures (see Section 1) are reached.

B. Conduct initial monitoring to determine first rest break.

1. Measure the air temperature with a standard thermometer with the bulb shielded from radiant heat; this yields T (actual).

2. Estimate the fraction of sunshine by judging what percent time the sun is not shielded by clouds that are thick enough to produce a shadow, as follows:

   a. 100 percent sunshine (e.g., no cloud cover) = 1.0

   b. 50 percent sunshine (e.g., 50 percent cloud cover) = 0.5

   c. 0 percent sunshine (e.g., full cloud cover) = 0.0

3. Plug these variables into the following equation to determine the adjusted temperature:

   T (adjusted) = T (actual) + (13 x fraction sunshine)

C. Body Temperature Monitoring

1. Monitor oral body temperature to determine if employees are adequately dissipating heat buildup. Ear probe thermometers which are adjusted to oral temperature are convenient and the preferred method of measurement. Determine work/rest regimen as follows:

    a. Measure oral body temperature at the end of the work period.

    b. If temperature exceeds 99.6 °F (37.5 °C), shorten the following work period by 1/3 without changing the rest period.

    c. If temperature still exceeds 99.6 °F (37.5 °C), shorten the following work period by 1/3.

    d. Do not allow a worker to wear impermeable PPE when his/her oral temperature exceeds 100.6 °F (38.1°C).

2. Oral body temperatures are to be obtained prior to the employee drinking water or other fluids.

D. Pulse Rate Monitoring

1. Take the radial (wrist) pulse as early as possible in the rest period.

    a. If the heart rate exceeds 110 beats per minute at the beginning of the rest period, shorten the next work cycle by one-third.

    b. If the heart rate still exceeds 110 beats per minute at the next rest cycle, shorten the following work cycle by an additional one-third.

E. Record monitoring results on Heat Stress Monitoring Form (Attachment 18-2).

F. Investigate the use of auxiliary cooling devices in extreme heat conditions.

G. Conduct briefings for employees regarding health hazards and control measures associated with heat stress whenever conditions require the implementation of heat stress monitoring. Review the information provided in Attachment 18-3.

H. Provide water and electrolyte replacement drinks fluids as described in Attachment 18-3.

I. Allow employees who are not accustomed to working in hot environments appropriate time for acclimatization (see Attachment 18-3).

J. Provide break areas as described in Attachment 18-3.

5. Documentation Summary

File these records in the Project Safety File.

A. Heat Stress Monitoring Forms.

B. Employee Safety Briefing Verification Forms.

6. Resources

A. NIOSH - "Working in Hot Environments"

B. AFL-CIO Building Trades Division - "Heat Stress in Construction"

C. Attachment 18-1 - Initial Work Monitoring Cycles

D. Attachment 18-2 - Heat Stress Monitoring Record

E. Attachment 18-3 -Informational Supplement

URS	Health, Safety and Environment INITIAL WORK / MONITORING CYCLES	Attachment 18-1

Adjusted Temperature	Normal Work Clothes	Protective Clothing
90 F (32.2 C) or above	After each 45 minutes of work	After each 15 minutes of work
87.5 F - 90 F (30.8 - 32.2 C)	After each 60 minutes of work	After each 30 minutes of work
82.5 F – 87.5 F (28.1 C – 30.8 C)	After each 90 minutes of work	After each 60 minutes of work
77.5 F – 82.5 F (25.3 C – 28.1 C)	After each 120 minutes of work	After each 90 minutes of work
72.5 F – 77.5 F (22.5 C – 25.3 C)	After each 150 minutes of work	After each 120 minutes of work

URS Corporation

URS Corporation Health & Safety Program
EMPLOYEE HEAT STRESS EXPOSURE MONITORING RECORD

DATE: _____ SAFETY REPRESENTATIVE: _____

WORKER'S NAME: _____ SUBCONTRACTOR: _____

WORK ACTIVITY: _____

Time (24 hour)	*Oral Temp (°F)*	*Pulse (BPM)*	*Comments*

DATE: _____ SAFETY REPRESENTATIVE: _____

WORKER'S NAME: _____ SUBCONTRACTOR: _____

WORK ACTIVITY: _____

Time (24 hour)	*Oral Temp (°F)*	*Pulse (BPM)*	*Comments*

DATE: _____ SAFETY REPRESENTATIVE: _____

WORKER'S NAME: _____ SUBCONTRACTOR: _____

WORK ACTIVITY: _____

Time (24 hour)	*Oral Temp (°F)*	*Pulse (BPM)*	*Comments*

HEAT RASH

Heat rash (prickly heat) may result from continuous exposure to heat or humid air. It appears as red papules (elevated skin lesion), usually in areas where the clothing is restrictive, and gives rise to a prickly sensation, particularly as sweating increases. It occurs in skin that is persistently wetted by un-evaporated sweat. The papules may become infected unless treated.

First Aid for Heat Rash - To prevent heat rash, shower after work, dry off thoroughly, and put on clean, dry underwear and clothes. Try to stay in a cool place after work. If, in spite of this, you develop heat rash, see your physician.

HEAT CRAMPS

Heavy sweating with inadequate electrolyte replacement causes heat cramps. Signs and symptoms include:

Muscle spasms.

Pain in the hands, feet and abdomen.

First Aid for Heat Cramps - Leave the work area, and rest in a cool, shaded place. Drink one or two glasses of electrolyte replacement drink, and try to gently massage the cramped muscle. Once the spasms disappear, you may return to work. Taking adequate breaks and drinking electrolyte replacement drink should prevent the cramps from returning.

HEAT EXHAUSTION

Heat exhaustion occurs from increased stress on various body organs including inadequate blood circulation due to cardiovascular insufficiency or dehydration. Signs and symptoms include:

Pale, cool, moist skin.

Heavy sweating.

Dizziness.

Nausea.

Fainting.

The key here is that the victim is still sweating, so the cooling system is still working; it's just under severe stress. The body core temperature may be elevated. It is important to

recognize and treat these symptoms as soon as possible, as the transition from heat exhaustion to the very hazardous heat stroke can be quite rapid.

First Aid for Heat Exhaustion - Leave the work area immediately. Go through decon and remove all chemical protective clothing. Rest in a cool, shaded place and open your clothing to allow air circulation; lay flat except when taking fluids. Drink plenty of cooled electrolyte replacement drinks. Your work is over for the day; do not attempt to return. Medical assistance in severe cases may be warranted.

HEAT STROKE

Heat stroke is the most serious form of heat stress. Temperature regulation fails and the body temperature rises to critical levels. Immediate action must be taken to cool the body before serious injury and death occurs. Competent medical help must be obtained. Signs and symptoms are:

Red, hot, usually dry skin.

Lack of or reduced perspiration (lack of perspiration may be masked for those wearing chemical protective clothing since perspiration from earlier in the day will be present).

Nausea.

Dizziness and confusion.

Strong, rapid pulse.

Coma.

First Aid for Heat Stroke - THIS IS A MEDICAL EMERGENCY! SUMMON MEDICAL ASSISTANCE IMMEDIATELY! Remove the victim from the work area, perform a gross decon, and remove all PPE. Have the victim lie down in a cool, shady area. Attempt to bring the victim's temperature down by increasing air movement (electric fan) or placing wetted sheets or towels on them. Place an ice bag on the victim's head. The victim must not be sent home or left unattended without a physician's specific order.

HEAT STRESS PREVENTION

The best approach to avoiding heat-related illness is through preventative heat stress management. The site manager and site safety officer are responsible for implementing this program.

Rest areas - A relatively cool, shaded area must be provided for breaks when ambient temperatures exceed 70 °F and workers are wearing chemical protective clothing (including uncoated Tyvek), or if temperatures exceed 90 °F and workers are wearing "Level D"

coveralls or work clothes. A car or van is an oven, not a rest area. For hazardous waste sites, the rest area should be located in the support zone adjacent to the contamination reduction zone, situated so that part of it is in the decon area so workers can take breaks without going through full decon. If shade is not available, build some. Use a plastic "dining canopy", which can be obtained at sporting goods stores. This same type of canopy can be set up to shade personnel performing various types of work in hot weather.

Liquids - Encourage employees to drink plenty of cool plain water and electrolyte replacement drinks. Supplementing water with cool electrolyte replacement drinks, such as Gatorade, Squench or Quik-kick (drink), is helpful to employees who tend to sweat a lot. Do not use "community cups"; use paper cups. Have workers drink 16 ounces of drink before beginning work, such as in the morning and after lunch. At each break, workers should drink 8 to 16 ounces. Don't wait until you are thirsty to drink.

Discourage the use of alcohol during non-working hours, and discourage the intake of coffee during work hours, as these make heat stress control more difficult.

Acclimatization - This is the process by which your body "gets used to" hot work environments. This is achieved by slowly increasing workloads. Start at 50 percent capacity on day one, and increase by 10 percent per day; on day six, you'll be at 100 percent. You don't lose acclimatization over a weekend, but it'll start to decrease after three to four days. If you don't do hot work for a week, it is gone. You don't have to do full shift hot work to achieve or retain acclimatization; a minimum of 100 minutes of continuous hot work exposure per day is adequate.

Auxiliary Cooling - Auxiliary cooling is usually obtained by providing workers with a specially-designed vest, which is worn under the protective clothing, but over any underclothing. These vests typically provide cooling via one of two methods: the use of ice or other frozen media, or the use of a vortex cooler. Each method has its advantages and disadvantages.

The frozen media vest requires a means for freezing the media, and the media (usually water or "blue ice") will melt, requiring replacement.

The vortex cooler tends to cool more uniformly. Instead of frozen media, this vest uses the expansion of compressed air to cool the wearer. The drawback is the compressed air requirement, but this is negated when the wearer is already using an airline respirator supplied by a compressor. A vortex cooler should not be supplied from air cylinders, as this will draw down the cylinders rapidly.

Auxiliary cooling should be considered when the following conditions exist:

Ambient temperature over 80 °F

Workers are wearing impermeable garments (i.e., Tyvek, Saranex, Chemrel, etc.)

It is desirable to have long work shifts with minimum interruption

URS SAFETY MANAGEMENT STANDARD
Heavy Equipment Operations

1. Applicability

This procedure applies to URS field projects where heavy equipment is in operation.

2. Purpose and Scope

The purpose of this procedure is to require that heavy equipment is operated in a safe manner, that the equipment is properly maintained and that ground personnel are protected.

3. Implementation

Field Activities - Implementation of this procedure is the responsibility of the Project Manager.

4. Requirements

A. Authorized Operators

1. Evaluate operators through documentable experience (resume) and a practical evaluation of skills.
2. Allow only qualified operators to operate equipment.
3. Prohibit equipment from being operated by any personnel who have not been specifically authorized to operate it.
4. Maintain a list of operators for the project and the specific equipment that they are authorized to operate.
5. Require operators to use seat belts at all times in all equipment and trucks.
6. Prohibit personnel other than the operator from riding in or on the equipment unless additional seating (with seat belts) is provided by the manufacturer.
7. Operators shall maintain three points of contact whenever entering and exiting a piece of equipment.
8. Brief operators on the following rules of operation:
    a. Operators are in control of their work area.

b. Equipment will be operated in a safe manner and within the constraints of the manufacturer's Operation Manual.

c. Operators will stop work whenever unauthorized ground personnel or equipment enter their work area and only resume work when the area has been cleared.

B. Ground Personnel

1. Require that ground personnel on the site have received training and comply with the following rules of engagement:

   a. All ground personnel must wear high visibility protective vests when in work areas with any operating equipment.

   b. Ground personnel will stay outside of the swing zone or work area of any operating equipment.

   c. Ground personnel may only enter the swing or work area of any operating equipment when:

      1. They have attracted the operator's attention and made eye contact.

      2. The operator has idled the equipment down and grounded all extensions.

      3. The operator gives the ground personnel permission to approach.

   d. Ground personnel shall never walk or position themselves between any fixed object and running equipment or between two running pieces of equipment.

C. Equipment

1. Maintain operations manuals at the site for each piece of equipment that is present on the site and in use.

2. Require that operators are familiar with the manual for the equipment and operate the equipment within the parameters of the manual.

3. Require that all equipment is provided with roll-over protection systems (ROPS). Tracked excavators are exempt from ROPS requirements but must have a cab which provides protection from overhead hazards

4. Verify that seatbelts are present and functional in all equipment.

5. Prohibit the use of equipment which has cab glass which is cracked, broken or missing.

6. Require that backup alarms are functional on all trucks and equipment. Tracked excavators must have bidirectional alarms or the operator must be provided with a spotter whenever tracking in either direction.

7. Require all extensions such as buckets, blades, forks, etc. to be grounded when not in use.

8. Require brakes to be set and wheels chocked (when applicable) when not in use.

D. Inspection and Maintenance

1. Require daily inspections of equipment by operators using Attachment 19-1.

2. Prohibit use of equipment deemed to be unsafe as a result of daily inspection until required repairs or maintenance have been completed.

3. Conduct maintenance as prescribed by the manufacturer in the Operations Manuals for each piece of equipment.

4. During maintenance/repair, require that:

   a. Motors are turned off.

   b. All extensions are grounded or securely blocked.

   c. Controls are in a neutral position.

   d. Brakes are set.

5. Documentation Summary

File the following documents in the Project Health and Safety File.

A. List of authorized operators.

B. Operator qualifications.

C. Daily Equipment Inspection Logs.

D. Site briefing documentation for operator rules and ground personnel "rules of engagement".

6. Resources

A. U.S. OSHA Standard - Motorized Vehicles and Mechanized Equipment - 29 CFR 1926, Subpart O

B. National Association of Demolition Contractors – Safety Manual

C. Queensland Workplace Health and Safety - Competency Standard for Users & Operators of Industrial Equipment

D. Attachment 19-1 - Equipment Inspection Form

URS	Health, Safety, and Environment **DAILY HEAVY EQUIPMENT SAFETY INSPECTION CHECKLIST**	Attachment 19-1

Equipment Id No. _____ Inspector's Name _____

Equipment Name _____ Employee No. _____

Beg. Hours _____ End Hours _____ Date _____

INSTRUCTIONS: Each shift shall inspect all applicable items indicated. If an unsatisfactory condition is observed, suspend operation of the equipment and report the unsatisfactory condition to the site supervisor immediately.

ITEM INSPECTED	CHECK IF SATISFACTORY	COMMENTS
Falling Object Protective Structure (FOP)		
Roll-Over Protection Structure (ROP)		
Seat Belts		
Operator Seat Bar(s)		
Side Shields, Screens or Cab		
Lift Arm Device		
Grab Handles		
Back-up Alarm – Working		
Lights		
Guards		
Horn		
Windshield Wipers		
Glass, Mirrors		
Anti-Skid Tread Clear of Mud		
Safety Signs (i.e., counterbalance swing area)		
Fire Extinguisher		
General Condition		
Fuel Connection		
Oil (fuel and no leaks)		
Clear of Extra Materials		
Controls Function Properly		
Hydraulic System (full and no leaks)		
Parking Brake		
Lift Arm and Bucket		
Tires/Tracks		
Steering		
Breathing Air System		
Blast Shields		
Gallons of Fuel Added		
Quarts of Oil Added		

Operator Signature _____

URS SAFETY MANAGEMENT STANDARD
Housekeeping

1. Applicability

This procedure applies to URS facilities and field operations.

2. Purpose and Scope

Proper housekeeping in office locations, on construction sites, and fixed work facilities is essential to prevent fires as well as injuries resulting from slips, trips and falls.

3. Implementation

Office Locations - Implementation of this program is the responsibility of the Office Manager.

Field Activities - Implementation of this program is the responsibility of the Project Manager.

4. Requirements

A. Maintain the cleanliness of the site.

1. Require tools and equipment to be stowed at the end of the day.
2. Store supplies in locations away from walkways and in a manner that will not trip workers.
3. Keep weeds and vegetation away from stockpiled materials and walkways.
4. Maintain flooring and walkways in a clean, dry, smooth condition.
5. Dispose of construction debris in a timely manner.

B. Regularly inspect the work area for slip and trip hazards.

1. Office locations - inspect work areas at least semi-annually. Utilize the check-sheet provided as Attachment 21-1.
2. Field sites - inspect sites at least monthly. Utilize the check- sheet provided as Attachment 21-1.

C. Thoroughly investigate all injuries resulting from slips, trips and falls on site. Correct conditions contributing to injuries.

5. Documentation Summary

A. Office/Laboratory

File Completed Housekeeping Inspection Sheets (Attachment 21-1), in the Office Safety Filing System.

B. Field

File Completed Housekeeping Inspection Sheets (Attachment 21-1), in the Project Safety File.

6. Resources

A. U.S. OSHA Standard - Sanitation - 29 CFR 1910.141

B. U.S. OSHA Standard - Aisles and Passageways - 29 CFR 1910.22.

C. U.K. - 'The Workplace' (Health & Safety and Welfare) Regulations

D. U.K. - 'The Construction' (Health and Welfare) Regulations

E. Attachment 21-1 - Housekeeping Inspection Sheet

URS	Health, Safety and Environment **HOUSEKEEPING INSPECTION SHEET**	Attachment 21-1

Building or Location: _____

Inspection Conducted by: _____ **Date:** _____

		Yes	No (must be completed)	N/A
	General Site Housekeeping			
1.	No blocking of exits or emergency equipment.			
2.	Equipment or materials are not left lying on the ground.			
3.	Storage areas are free from the accumulation of materials that constitute trip hazards.			
4.	Scrap materials and other debris is kept free from work area.			
5.	Combustible scrap and debris is removed by safe means at regular intervals.			
6.	Oily rags are stored in metal cans with tight fitting lids. Oily rags are removed at the end of the day.			
	Visibility			
7.	Halls, stairways and walkways are well lit.			
8.	Well designed light switches are present in areas where walkways are not always lighted.			
9.	Dust, smoke or steam does not create poor visibility.			
10.	Glare from floodlights or windows does not create poor visibility in work areas.			
	Stairs			
11.	Handrails are tight and at the proper level.			
12.	Handrails extend past the top and bottom step.			
13.	White or yellow strips are painted on the first and last step for better visibility. (Not an OSHA requirement – recommendation only).			
14.	Steps are not rough or defective.			
15.	Stair treads are wide enough and risers consistently spaced.			
16.	Stairs are free of obstructions.			
	Floor Conditions			
17.	Floors of every workroom are clean, and so far as possible, in a dry condition.			
18.	Floors are not oily or overly waxed or polished.			
19.	Where wet floors or processes are present, proper drainage is provided and false floors, mats, or other dry standing places are provided.			
20.	Floor surfaces are finished with non-slip coatings where spills are likely.			
21.	Floors and passageways are free from protruding nails, splinters, holes, or loose boards.			

URS	Health, Safety and Environment HOUSEKEEPING INSPECTION SHEET	Attachment 21-1

		Yes	No must be completed	N/A
22.	Floors are free of holes and depressions.			
23.	Aisles or pathways are wide enough for easy passage and for carrying objects (48 inches is recommended).			
24.	Ramps are covered with non-slip surfaces or matting.			
25.	Carpets or rugs do not have loose or frayed edges that may catch boots or shoes.			
26.	Walkways are free from extension cords, air hoses and cables.			
27.	Boxes, containers, machine parts or other tripping hazards do not lie in pathways.			
	Ground Conditions			
28.	Trip hazards are not present.			
29.	Fall hazards are not present.			
30.	Holes or changes in ground elevation are either filled or guarded.			
31.	Muddy walkways are filled with gravel to reduce slipping.			
32.	All employees who work in wet or greasy conditions wear slip resistant footwear.			
	Equipment			
33.	Vehicle steps are of adequate size, surface placement for safe dismounting.			
34.	Hand grips or ladders are adequate for getting in and out of equipment.			
35.	Ladders have been checked for damage and removed from service if found unsafe.			

I certify that the above inspection was performed to the best of my knowledge and ability, based on the conditions present on _____

_____

Signature

URS SAFETY MANAGEMENT STANDARD
Medical Screening & Surveillance

1. Applicability

This program applies to employees assigned to work environments where there is a potential for exposure to chemical, biological, and/or physical hazards. Individuals will be selected for medical screening based on regulatory standards, project health and safety plan assessments, the expected use of personal protective equipment, and client contract requirements.

2. Purpose and Scope

The overall goal of this program is to prevent occupational illness and injury by early identification of exposure-related health effects before they result in disease. Medical examinations will be performed in order to determine if employees are capable of safely performing assigned tasks, to verify protective equipment and controls are effectively providing protection, and to comply with governmental regulations. Included are provisions for emergency medical consultation and treatment.

3. Implementation

Office/laboratory locations – Implementation is the responsibility of the Office Manager.

Field activities – Implementation is the responsibility of the Project Manager.

Program Administration – The Occupational Health Specialist (OHS) is responsible for development and administration of this program in coordination with the URS Medical Service Provider (MSP). The OHS will maintain current injury and illness data and participate with Corporate Health & Safety Managers in evaluation of this program. The MSP will provide board certified occupational medicine oversight for the program and will approve medical surveillance protocols.

The United States and Canada locations will follow all requirements of this program.

International locations will follow sections B.1,2,3,5,6,7,8; G.3; and H.1 of this program.

4. Requirements

A. Selection of program participants.

1. The Medical Surveillance Evaluation (MSE) form provides the primary guidance for determining whether medical screening is required for an employee and the frequency of periodic exams. The MSE is to be completed by the employee and their supervisor at time of hire for any employee who may work outside an office environment and is to be reviewed for accuracy at each annual performance review. Other reviews are required whenever there is a change in job tasks.

2. Additional site/project specific biological monitoring or toxicological screening may be required in addition to this program's core exam schedule. These medical tests will be specified by the project-specific health and safety plan and will be authorized by the MSP on the exam appointment protocol. Note: See section D.2 if employee will have an initial assignment at a HAZWOPER site.

B. Types of medical screening and surveillance exams

1. A baseline or preassignment baseline exam will be conducted prior to the start of work assignments requiring medical surveillance.

2. Periodic exam schedules are established by the MSP using the following criteria:

   a. Employees performing the following types of work will receive annual exams: construction activities in the exclusion zone of HAZWOPER sites, field work activities in the exclusion zone of HAZWOPER sites for 30 or more days per year, projects involving exposure to OSHA-regulated materials at or above established action levels.

   b. Employees performing the following types of work will receive biennial exams: field work activities at HAZWOPER sites less than 30 days per year; waste disposal activities; non-HAZWOPER environmental sampling; chemistry laboratory, pilot plant projects, or bench scale operations for 30 or more days per year.

3. Employees currently participating in an examination program will receive exit exams when they leave their work assignment as identified in the Exit Exam Determination. In the event an employee declines the exit exam, the employee will be requested to sign a Waiver of Exit Medical Surveillance Exam.

4. Department of Transportation (DOT) exams will be conducted biennially when an employee is assigned to drive a vehicle with a gross weight rating of more than 10,000 pounds or when driving a placarded vehicle of any size used to transport hazardous chemicals. DOT exam certification can be added to a routine baseline or periodic exam protocol when scheduling with the MSP.

5. When noise levels in the employee's work environment equal or exceed an 8-hour time-weighted average of 85 decibels as measured on the A-scale (dBA), annual audiograms will be performed. For employees involved in construction activities or management of construction, enrollment in this program will be required if more than 50% of their time is spent in an active construction area.

6. Individual radiation dose monitoring will be conducted as required by the site-specific health and safety plan with approval by a Radiation Safety Officer. Personal dosimetry (film badges) are typically required, however, depending on the specific radiation hazard, additional excretory monitoring or thyroid scans may be required.

7. In order to determine an employee's ability to wear a respirator, a medical evaluation will be performed before an employee is fit tested or assigned to wear a respirator.

8. Employees assigned to work environments with airborne concentrations of asbestos fibers at or above the established action level will receive asbestos-specific baseline and annual exams. Exit exams will be performed if an exam has not been performed within the past 6 month period or if an employee has medical complaints related to asbestos exposure.

C. Exam protocols

1. The Medical Screening & Surveillance Exam Protocol identifies the medical exam components of this program.

D. Scheduling of exams

1. The Office or Project Manager, usually with assistance of the local H&S Representative, is responsible for contacting the MSP when baseline, exit, and project specific exams are required. The MSP maintains an employee scheduling database for tracking periodic

exams and will contact the employee for scheduling the month their exam is due. These steps are detailed in the Medical Surveillance Exam Process.

2. Construction Services Division employees hired with an initial assignment to work at a OSHA HAZWOPER site whose work duties require passing a physical exam or who have an essential job function of wearing a respirator, will receive a job offer contingent upon passing a preassignment baseline exam. See HAZWOPER & Respirator Preassignment Baseline Exam Process. In the event of an urgent business necessity a temporary clearance to begin work the day of the exam, issued by the local physician and good for 14 days until the MSP physician final clearance is received, may be requested at the time a baseline exam is scheduled through the MSP.

3. If an exam becomes due during an employee's pregnancy, it is advised to defer the exam until after delivery and the employee returns to work from family/medical leave status.

E. Exam Follow Up

1. Following each exam, the MSP will issue a physician's written opinion (Health Status Medical Report) to the site Health & Safety Representative which will include any medical restrictions and address the employee's ability to use personal protective equipment. See Exam Follow Up Procedures.

2. The MSP will mail the exam invoice to the site H&SR who will approve the charge and forward the invoice to the accounts payable department for payment.

3. The MSP will mail an exam results letter that is confidentially addressed to the employee at their home address within 30 days of the exam date.

F. Emergency Medical Care

1. Preplanning is essential to a prompt and proper response to a medical emergency. Site specific emergency procedures will be provided in the site Health & Safety Plan. See Field First Aid Kit Supply List for recommended supplies. The contents of the first aid kit shall be checked prior to being sent out to each site/project and periodically thereafter to ensure the expended items are replaced.

2. A MSP occupational physician can be reached 24 hours a day for phone consultation at WorkCare™ 1-800-455-6155.

3. A workers' compensation claim should be filed by the Human Resource Representative with AIG Claim Services (1-877-366-8423) for an injured employee who receives professional medical care or who is disabled from working beyond the initial date of injury.

4. In order to comply with OSHA reporting regulations, immediately notify the OHS or a Division Health & Safety Manager if there is a work-related hospitalization or death.

G. Medical Records

1. Medical records are maintained and preserved in confidential, locked files in the custody of the MSP for at least the duration of employment plus 30 years. Only information regarding the employee's ability to perform the job assignment will be provided to company representatives.

2. Upon request, each employee (or designated representative) will have access to the employee's medical record. Prior to the release of health information to the employee (or designated representative), a specific written consent must be signed by the employee.

3. International records (excluding the United States and Canada) will be maintained in country at the local clinic.

H. Program evaluation

1. The OHS and Division Health & Safety Managers will evaluate this program annually and as needed. Issues to review include program efficacy and efficiency, employee satisfaction, and cost effectiveness.

2. The MSP will prepare an Annual Medical Trending Report specifying the number and types of exams performed and anonymous statistical exam results in group data format.

3. Each employee is mailed a Post-Exam Evaluation by the MSP. Employee feedback regarding the clinic, medical staff, and exam

procedures are reviewed and corrective actions are identified and acted upon as needed.

5. Documentation Summary

The H&SR will file the Medical Surveillance Evaluation and the Health Status Medical Report in the site health & safety records.

6. Resources

A. U.S. OSHA Technical Links - Medical Screening/Surveillance

B. U.S. OSHA Publication 3162 (1999) Screening and Surveillance: A Guide to OSHA Standards

C. Attachment 24-1 WorkCare Medical History Questionnaire

D. Attachment 24-2 Medical Surveillance Evaluation

E. Attachment 24-3 Medical Screening & Surveillance Exam Protocol

F. Attachment 24-4 Medical Surveillance Exam Process

G. Attachment 24-5 HAZWOPER/Respirator Preassignment Baseline Exam Process

H. Attachment 24-6 Exit Exam Determination

I. Attachment 24-7 Waiver of Exit Medical Surveillance Exam

J. Attachment 24-8 Exam Follow Up Procedures

K. Attachment 24-9 Field First Aid Kit Supply List

L. SMS 8 Asbestos Survey and Oversight Operations

M. SMS 17 Hazardous Waste Operations

N. SMS 42 Respiratory Protection

Medical History Questionnaire

☐ Baseline ☐ Annual/Biennial

☐ Exit ☐ Other _____

Company Name:_____

Office:_____

Date:_____

URS

Medical History Questionnaire

The exam will be at: *Please see Appointment Protocol.*

- Please have your Supervisor or Health & Safety Professional complete the Job Profile on the inside flap of this page if you do not know the responses.

- See your Health & Safety Professional for directions to the clinic. Please bring the completed exam packet and your Authorization.

- Do not eat for 8 hours prior to exam.
  (Water and unsweetened juice or black decaffeinated coffee are allowed)
  (Dry toast if you have an afternoon appointment)

- Avoid all alcohol consumption for 24 hours prior to the exam.

- Avoid loud noise exposure for 14 to 16 hours before the exam.

- If you wear contact lenses, please do not insert them on the day of the exam. Bring a pair of glasses.

- If you use hearing aids, please bring them to the clinic.

- If you have questions, do not read or understand please contact (800) 455-6155.

- The cost of this exam will be borne by your employer. It is important to be on time for your appointment. If you cannot attend your appointment, call (800) 455-6155 to cancel, or your employer may be charged.

Please answer all the questions in this booklet.

Occupational Medicine • Environmental Health • Toxicology

1-(800) 455-6155

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I INSTRUCTIONS

Your supervisor must allow you to answer this questionnaire during normal working hours, or at a time and place that is convenient to you. To maintain your confidentiality, your employer or supervisors must not look at or review your answers, and your employer must tell you how to deliver or send this questionnaire to the healthcare professional who will review it.

Has your employer told you how to contact the healthcare professional who will review this questionnaire? Yes ☐ No ☐

This questionaire is used to gather information about your health and physical condition, both now and in the past. This information will be used to determine if you can safely perform the duties of your job. This exam is not intended to substitute for care provided by a personal physician. Results of the exam will be sent to your home address. The results of the examination are kept confidential.

I. 1. Print the following information:

Last Name: _____ First Name: _____

Home mailing address: _____

_____
(city) (state) (zip)

Social Security Number: _____ Date of Birth: _____ Age: _____

Sex	Position	Site Location	Date Employed
[ ] Male [ ] Female			

Home Phone	Work Phone	Emergency Contact/Phone #
( )	( )	( )

What is the phone number at which you can be reached by the healthcare professional who reviews this questionnaire (include area code:) (____) _____

What is the best time to reach you? From: _____ AM/PM To: _____ AM/PM

E-mail: _____

2. **Read and sign this Consent for Release of Medical Records:**
I hereby authorize WorkCare to release in confidence to _____(company) and/or its subsidiaries medical information, including but not limited to the results of medical evaluations, physical examinations or medical testing, as it specifically pertains to my medical qualification to perform the stated Job Duty consistent with the requirements of OSHA, MSHA.
I further authorize the examining physician and/or clinic to release to WorkCare™ any medical information related to my medical or physical condition. You have a right to receive a copy of this authorization.

Signature: _____ Date: _____

Job Profile

II THIS SECTION IS TO BE COMPLETED

If you have questions about the job, these need to be discussed with the employer.

JOB DUTY / TITLE What is the main job duty (present or proposed) for this individual?
(Example: Driller, Water Treatment, Ground Water Sampling, Engineer, Environmental Scientist, Lab Tech, Heavy Equipment Operator, Maintenance Worker, etc.)

_____

_____

WORK SCHEDULE _____ % Field _____ % Office _____ % Travel

PHYSICAL REQUIREMENTS

Are there any specific physical demands of the job that are important? (example: lifting, carrying) Yes ☐ No ☐
If yes, please specify:

_____

PROTECTIVE EQUIPMENT

Is clearance for the use of respiratory protective equipment needed? Yes ☐ No ☐

Escape only (no rescue) ☐ Emergency rescue only ☐

Is there specific safety equipment (beyond hard hat, gloves, boots, and appropriate clothing) that are used in the safe performance on the job? If yes please specify: Yes ☐ No ☐

_____

1. **THIS EMPLOYEE USES THE FOLLOWING TYPES OF RESPIRATORY PROTECTIVE EQUIPMENT:**

✓		DURATION	FREQUENCY	TEMPERATURE EXTREMES	HUMIDITY
	HALF FACE PIECE AIR PURIFYING RESPIRATOR				
	FULL FACE PIECE AIR PUIRFYING RESPIRATOR				
	POWERED AIR PURIFYING REPIRATOR				
	SELF-CONTAINED BREATHING APPARATUS				
	AIR LINE RESPIRATOR				

Yes No

2. Is it possible that this individual will be required to wear Level A protection at any time? [SCBA, fully encapsulated suit, chemical resistant gloves & boots.] ☐ ☐

3. Is it possible that this individual will be required to wear Level B protection at any time? [SCBA, chemical resistant clothing, chemical resistant gloves & boots.] ☐ ☐

4. List potential chemical exposures

_____

	Yes	No
5. Will you be working under hot conditions (temperatures exceeding 77°F)?	☐	☐
Will you be working under humid conditions?	☐	☐
Will you be working at high altitudes?	☐	☐

Describe the work you'll be doing while you're using your respirator(s)._____

6. Describe any special or hazardous conditions you might encounter when you're using your respirator(s) (For example, confined spaces, life-threatening gases):_____

7. During the period you are using the respirator(s), is your work effort:
   a. Light (less than 200 kcal per hour) Yes ☐ No ☐ How long_____hrs per shift
   b. Moderate (200 to 359 kcal per hour) Yes ☐ No ☐ How long_____hrs per shift
   Examples: sitting while mailing or filing; driving a truck or trasferring a moderate load (about 35 lbs) at trunk level; walking on a level surface about 2 mph
   c. Heavy (above 350 kcal per hour) Yes ☐ No ☐ How long_____hrs per shift
   Examples: lifting a heavy load (about 50 lbs.) from the floor to your waist; working on a loading dock; shoveling; standing while bricklaying; climbing stairs with a heavy load (about 50 lbs.)

8. Describe any special responsibilities you'll have while using your respirator(s) that may affect the safety and well-being of other (e.g. rescue, security):_____

9. Are there any substances which you can not work with? List:_____

III REVIEW OF SYSTEMS

ANSWER YES IF YOU CURRENTLY HAVE THE SYMPTOM OR HAVE HAD SIGNIFICANTLY IN THE PAST

		YES	NO	DATE
1.	A. Fever			
	B. Chills			
	C. Weight Loss			
	D. Loss of energy/fatigue			
2.	A. Poor Vision			
	B. Color Blindness			
	C. Double vision			
	D. Injury to eye			
	E. Cataract			
	F. Glaucoma			
	G. Do you wear glasses or contacts?			
3.	A. Ear Infection			
	B. Mastoid surgery			
	C. Loss of hearing			
	D. Sore throat			
	E. Frequent hoarseness			
	F. Dental problems			
4.	A. Allergies			
	B. Sinus trouble			
	C. Hay fever			
5.	A. Tuberculosis			
	B. Asthma & breathing difficulties			
	C. Lung collapse			
	D. Pneumonia			
	E. Shortness of breath			
	F. Persistent or severe colds			
	G. Persistent or severe coughs			
	H. Chest surgery			
	I. Wheezing			
	J. Emphysema			
	K. Bronchitis			
6.	A. High blood pressure			
	B. Heart murmur			
	C. Enlarged heart			
	D. Heart disease/failure			
	E. Rheumatic fever			
	F. Heart palpitations			
	G. Irregular heart beat			
	H. Heart attack			
	I. Chest pain			
7.	A. Varicose veins			
	B. Stroke			
	C. Leg ulcers			
	D. Swelling of ankles			
	E. Leg pain on walking			
8.	A. Anemia			
	B. Leukemia			
	C. Sickle Cell Disease			
	D. Other blood disease			
9.	A. Diabetes			
	B. Thyroid problems			
	C. Cancer or tumors			
	D. Heart related illness			
10.	A. Rash/dermatitis			
	B. Bruise easily			
	C. Psoriasis			
	D. Wart/mole change			
	E. Eczema/Acne			

		YES	NO	DATE
11.	A. Headaches			
	B. Head injury			
	C. Neck injury			
12.	A. Birth defect			
	B. Frequent backaches			
	C. Back surgery			
	D. Disc disease			
	E. Back injury or strain			
	F. Back x-rays			
	G. Chiropractic treatments			
	H. Arthritis/Rheumatism			
	I. Knee problems			
	J. Swollen joints			
	K. Amputation			
	L. Broken Bones			
	Type:			
	M. Dislocations			
	N. Carpal Tunnel Syndrome			
	O. Repetitive Strain Extremities			
13.	A. Ulcers			
	B. Colitis			
	C. Diarrhea (frequent)			
	D. Stomach problems			
	E. Vomiting			
	F. Bloody bowel movements			
	G. Hepatitis/Abnormal liver enzymes			
	H. Cirrhosis			
	I. Yellow Jaundice			
	J. Gallbladder trouble			
14.	A. Epilepsy/seizures			
	B. Fainting spells			
	C. Loss of consciousness			
	D. Dizziness or vertigo			
	E. Frequent exhaustion			
	F. Trouble with nerves			
	G. Frequent worry/depression			
15.	A. Kidney trouble/stones			
	B. Bladder trouble			
	C. Kidney/bladder surgery			
	D. Blood in urine			
	E. Difficulty urinating			
16.	A. Venereal disease			
	B. Infertility/difficulty conceiving			
	C. Children with birth defects			
17. Female	A. Irregular period/painful menstruation			
	B. Hysterectomy			
	C. Are you pregnant?			
	D. Have you difficulty becoming pregnant?			
	E. Date of last menstrual period			
	F. Date of past pelvic/pap smear			
	G. Date of last mammogram			
	H. Breast lumps			
	I. Breast discharge			
	J. Repeated miscarriages			
18. Male	A. Inability to have an erection			
	B. Discharge or bleeding from the penis			
	C. Abnormal testicular self examination			
	D. Prostate problems			

Describe fully any "Yes" responses by number: _____

_____

Are you currently unable to perform any type of activity? Yes ☐ No ☐ List: _____

_____

IV SOCIAL HISTORY

	YES	NO
1. Do you now or in the past month smoke cigarettes?	☐	☐
2. Have you ever smoked cigarettes in the past?	☐	☐
3. If you now smoke or smoked in the past, how many years total have you smoked? (Write in number)_____		
4. If you now smoke or have smoked in the past, how many packs per day do/did you smoke on the average? (Choose the closest number)		

☐ Less than one-half(½) ☐ One (1) ☐ One and one-half(1½)
☐ Two (2) ☐ Two and one-half (2½) ☐ Three (3)
☐ More than three

5. Do you use any one of the following tobacco products?	☐	☐

☐ Pipe Tobacco ☐ Cigars ☐ Snuff ☐ Smokeless Tobacco

6. Do you regularly drink alchoholic beverages?	☐	☐

FOR QUESTIONS 7-9, CHOOSE THE ANSWER WHICH BEST FITS YOU.

7. If yes, how many drinks, beers or glasses of wine do you drink daily?
   ☐ Less than 1 ☐ 1-2 ☐ 3-4
   ☐ 5-6 ☐ 7-8 ☐ More than 8
8. Do you have strenuous exercise for at least 45 min.?
   ☐ Daily ☐ 3 times a week ☐ 1 time a week
   ☐ Rarely ☐ Never
9. Do you feel frustated, stressed or uptight?
   ☐ Daily ☐ 3 times a week ☐ 1 time a week
   ☐ Rarely ☐ Never
10. Do you eat greasy or fatty foods?
   ☐ Daily ☐ 3 times a week ☐ 1 time a week
   ☐ Rarely ☐ Never
11. Do you use street drugs? ☐ Yes ☐ No

V PAST MEDICAL HISTORY

For Annual or Exit Exam - Indicate Change Since Last Exam

1. Are you currently being treated for illness or injury? ☐ Yes ☐ No
2. Have you been treated for persistent illness or injury? ☐ Yes ☐ No
3. Describe fully any "Yes" responses. _____

4. Please list HOSPITAL ADMISSIONS: ☐ If none, check here

YEAR	REASON FOR HOSPITALIZATION
19____	_____
19____	_____
19____	_____

5. Please list allergies to any medication, food, clothing, bee stings or other substances:
   _____
   _____
   _____

6. How many days of work did you miss in the last 12 months due to your health? _____

	YES	NO
7. Have you ever pursued a compensation claim or received disability payment for occupational injury or disease?	☐	☐
8. Have you ever been turned down for life insurance?	☐	☐
9. Have you had injuries from an auto accident?	☐	☐

VI CURRENT MEDICINES

When was the last year you received a tetanus immunization booster? _____ (mo.) / _____ (day) / _____ (yr.)

Do you currently have presciptions for drugs or medications? ☐ Yes ☐ No Please specify:_____

Have you ever been addicted to or consistently used drugs? ☐ Yes ☐ No Please specify:_____

Do you take any of the following medications on a daily basis.

Heart Medicine	☐ Yes	☐ No	Aspirin	☐ Yes	☐ No
Thyroid medicine	☐ Yes	☐ No	Blood pressure medicine	☐ Yes	☐ No
Oral medicine for Diabetes	☐ Yes	☐ No	Diuretic (Water pill)	☐ Yes	☐ No
Insulin for diabetes	☐ Yes	☐ No	Medicine for seizures	☐ Yes	☐ No
Nerve or sleeping pills	☐ Yes	☐ No	Allergy/Asthma medications	☐ Yes	☐ No
Blood thinner	☐ Yes	☐ No	Other:_____		

VII FAMILY HISTORY

Father:	☐ Living	List Diseases _____	If dead, cause of death_____
Mother:	☐ Living	List Diseases _____	If dead, cause of death_____
Brothers:	☐ Living	List Diseases _____	If dead, cause of death_____
Sisters:	☐ Living	List Diseases _____	If dead, cause of death_____

Has any member of the family had any of the following:

Cancer	☐ Yes	☐ No	Diabetes	☐ Yes	☐ No	Nervousness	☐ Yes	☐ No
Insanity	☐ Yes	☐ No	Tuberculosis	☐ Yes	☐ No	Rheumatism	☐ Yes	☐ No
Kidney Disease	☐ Yes	☐ No	Heart Disease	☐ Yes	☐ No			

FOR INITIAL EXAMS ONLY

THIS PAGE IS TO BE COMPLETED ONLY AS INITIAL OR PRE-JOB EXAMS

VIII PAST JOB HISTORY

LIST ALL JOBS EVER HELD STARTING WITH YOUR FIRST - INCLUDE PART TIME AND VOLUNTEER WORK

NAME OF EMPLOYER	FROM MO/YR	TO MO/YR	# HRS WORKED PER WEEK/SHIFT	DESCRIPTION OF WORK	POTENTIAL HAZARDS (DUST, FUMES, CHEMICALS, HEAT, NOISE, PHYSICAL AGENTS, METALS, RADIATION)

IX TOXIC EXPOSURE HISTORY

At work or at home have you ever been exposed to hazardous solvents, hazardous airborne chemicals (e.g. gases, fumes, dust) or have you come into skin contact with hazardous chemicals?

List _____

_____

Have you worked with any of the materials, or under any of the conditions, listed below:

	YES	NO
Asbestos	☐	☐
Silica (e.g. sandblasting)	☐	☐
Coal (e.g. mining)	☐	☐
Grinding	☐	☐
Welding	☐	☐
Aerosols	☐	☐
Asphalt, pitch or tar	☐	☐
Beryllium	☐	☐
Cadmium	☐	☐
Cotton Dust	☐	☐
Pesticides	☐	☐
Fuel Specify:	☐	☐
Oils	☐	☐
Lead	☐	☐
Nickel/Chrome	☐	☐
Paint	☐	☐
Microwave/Radio Frequency	☐	☐
Nuclear Radiation/X-Ray	☐	☐
Fiberglass	☐	☐
Plastics	☐	☐
Solvents	☐	☐
Compressed Gases	☐	☐
Aluminum	☐	☐
Iron	☐	☐
Tin	☐	☐
Dusty Environments	☐	☐
Have you ever worked around excessive **noise?** Where? _____	☐	☐
Have you ever worked in an excessively **hot or cold environment?** Where? _____	☐	☐

	YES	NO
Have you ever worked around **vibration** or with **vibrating tools?**	☐	☐
Have you ever worked in a doctor's office, clinic or hospital where you might have had exposure to **biohazardous materials?**	☐	☐
Have you ever performed a **site assesment** on any of the above industry groups or materials? List: _____	☐	☐
Any other hazardous exposures If "yes," describe these exposures: _____	☐	☐

	YES	NO
Have you ever lived near large industrial plants or areas of air pollution?	☐	☐
Have you ever received hazardous duty or environmental pay?	☐	☐
Have you ever been in the military service?	☐	☐
If "yes" were you exposed to biological or chemical agents (either in training or combat?)	☐	☐
Have you ever worked on a HAZMAT team?	☐	☐

List any second jobs or side businesses you have:

_____

List your current and previous hobbies:

_____

RESPIRATOR USERS ONLY

THE FOLLOWING 2 PAGES ONLY NEED TO BE COMPLETED BY THOSE ASSIGNED TO USE REPIRATORS.
IF UNCERTAIN ABOUT RESPIRATOR USE, PLEASE COMPLETE

RESPIRATOR USE

	YES	NO
1. Have you ever worn a respirator in the past?	☐	☐

2. What type of respirator did you wear? (mark all that apply)
If no go to question 4
- ☐ Disposable particulate filter mask (non-cartridge dust mask)
- ☐ Half face cartridge respirator
- ☐ Full face cartridge respirator
- ☐ Powered air purifying respirator
- ☐ Supplied air (airline) respirator
- ☐ Self contained breathing apparatus (SCBA)
- ☐ Escape only respirator

3. If you've ever used a respirator, have you ever had any of the following problems?	YES	NO
Eye irritation	☐	☐
Skin allergies or rashes	☐	☐
Anxiety	☐	☐
General weakness or fatigue	☐	☐
Any other problem or difficulty that interfered with your use of a respirator	☐	☐

_____

_____

HEART, LUNGS, AND OTHER BODY SYSTEMS (CONT.)

	YES	NO
4. Have you ever had an abnormal EKG (Electrocardiogram)	☐	☐

Explain:

_____

5. Have you ever had any of the following cardiovascular or heart problems?	YES	NO
Heart attack	☐	☐
Stroke	☐	☐
Angina (chest pain)	☐	☐
Heart failure	☐	☐
High blood pressure	☐	☐
Swelling in your legs or feet (not caused by standing or walking)	☐	☐
Heart arrhythmia	☐	☐
Any other heart problem that you have been told about	☐	☐

6. Have you ever had surgery of the arteries, coronary bypass or angioplasty (to correct blocked artery or aneurysm)? (mark only 1 answer)	YES	NO
Yes, within the past year	☐	☐
Yes, more than 1 year ago	☐	☐
No	☐	☐

6. Have you ever had any of the following pulmonary or lung problems?	YES	NO
Asbestosis	☐	☐

HEART, LUNGS, AND OTHER BODY SYSTEMS (CONT.)

	YES	NO
Asthma	☐	☐
Chronic bronchitis	☐	☐
Emphysema	☐	☐
Pneumonia	☐	☐
Tuberculosis	☐	☐
Silicosis	☐	☐
Lung cancer	☐	☐
Broken ribs	☐	☐
Pneumothorax (collapsed lung)	☐	☐
Any chest injuries or surgeries	☐	☐

8. Have you ever had seizures (fits)?	☐	☐
9. Have you ever been told you had diabetes (sugar disease)?	☐	☐
10. Have you ever had allergic reactions that interfere with your breathing?	☐	☐
11. Have you ever experienced claustrophobia (fear of closed-in places)?	☐	☐
12. Have you ever had trouble smelling odors?	☐	☐

13. Have you ever had any of the following pulmonary, cadiovascular, lung or heart symptoms?		
Shortness of breath	☐	☐
Shortness of breath when walking fast on level ground or walking up a slight hill or incline	☐	☐
Shortness of breath when walking with other people at an ordinary pace on level ground	☐	☐
Have to stop for breath when walking at your own pace on level ground	☐	☐
Shortness of breath when washing or dressing yourself	☐	☐
Shortness of breath that interferes with your job	☐	☐

14. Do you currently take medication for any of the following problems?		
Breathing	☐	☐
Heart trouble	☐	☐
Blood pressure	☐	☐
Seizure (fits)	☐	☐

15. Have you within the past had any of the the following symptoms of lung illness?		
Coughing that produces phlegm (thick sputum)	☐	☐

HEART, LUNGS, AND OTHER BODY SYSTEMS (CONT.)

	YES	NO
Coughing that occurs mostly when you are lying down	☐	☐
Coughing up blood in the last month	☐	☐
Wheezing	☐	☐
Wheezing that interferes with your job	☐	☐
Chest pain when you breath deeply	☐	☐
Coughing that wakes you early in the morning	☐	☐
Any other symtoms that you think may be related to lung problems	☐	☐

16. Have you ever had any of the following cardiovascular or heart symtoms?

Frequent pain or tightness in your chest	☐	☐
Pain or tightness in your chest during physical activity	☐	☐
Pain or tightness in your chest that interferes with your job	☐	☐
In the past two years, have you noticed your heart skipping or missing a beat?	☐	☐
Heartburn or indigestion that is not related to eating	☐	☐
Any other symtoms that you think might be related to heart or circulation problems	☐	☐

FULL FACE OR SCBA REPIRATOR USER ONLY

The following questions must be answered by every employee who has been selected to use either a full-face piece respirator or Air Supply Respirator (Self-Contained Breathing Apparatus [SCBA] or air line).

	YES	NO
17. Have you ever lost vision in either eye (temporarily or permanently)?	☐	☐
18. Do you currently have any of the following vision problems?		
Wear contact lenses	☐	☐
Wear glasses	☐	☐
Color blind	☐	☐
Any other eye or vision problem	☐	☐

FULL FACE OR SCBA REPIRATOR USER ONLY (CONT.)

	YES	NO
19. Have you ever had an injury to your ears, including a broken ear drum?	☐	☐
20. Do you currently have any of the following hearing problems?		
Diffculty hearing	☐	☐
Wear a hearing aid	☐	☐
Any other hearing or ear problem	☐	☐

Explain: _____

_____

_____

_____

21. Have you ever had a back injury?	☐	☐
22. Do you currently have any of the following muscle or skeletal problems?		
Weakness in any of your arms, hands, legs or feet	☐	☐
Back pain	☐	☐
Difficulty fully moving your arms and legs	☐	☐
Pain or stiffness when you lean forward or backward at the waist	☐	☐
Difficulty fully moving your head up and down	☐	☐
Difficulty fully moving your head side to side	☐	☐
Difficulty bending at your knees	☐	☐
Difficulty squatting to the ground	☐	☐
Difficulty climbing a flight of stairs or a ladder carrying more than 25 lbs.	☐	☐
Any other muscle or skeletal problems that might interfere with using a respirator	☐	☐

Explain: _____

_____

_____

_____

X FOR YEARLY / EXIT EXAMINATIONS ONLY

1. a. Approximately how many days of hazardous field work have you performed since your last examination? _____
   b. Approximately how many days in Level C (using an air-purifying respirator)? _____
   c. Approximately how many days in Level B (self-contained breathing apparatus or air line)? _____
2. Approximately how many different hazardous material sites have you worked on since your last examination? _____
3. What were the chemical or other hazards of concern to which you have potential exposure since your last examination? (e.g. gasoline, arsenic, trichlorethylene, radiation, asbestos)

Chemicals of Concern	Approximate # of Days	Exposure Frequency			Exposure Duration		
		Daily	Weekly	Monthly	< 1 Hr.	1-8 Hrs.	> 8 Hrs.

4. **Since your last exam,** have you had difficulty doing your job because of:

a.	Sensitivity to chemicals, dust, sunlight, etc.? (circle one)	**Yes**	**No**	**Don't Know**
b.	Inability to perform certain motions? (circle one)	**Yes**	**No**	**Don't Know**
c.	Inability to assume certain positions? (circle one)	**Yes**	**No**	**Don't Know**
d.	Heat Stress? (circle one)	**Yes**	**No**	**Don't Know**
e.	Other medical reasons? (circle one)	**Yes**	**No**	**Don't Know**

5. Have you experienced any health symptoms that may be related to exposures to hazardous materials since your last examination? If so, please describe:

_____

6. **Since your last examination,** have you had any type of illness that resulted in more than 3 consecutive days lost time from work? Yes No List: _____

7. Do you feel that you have and/or had exposure to ticks? [ ] No [ ] Yes When _____
   If "Yes", how would you quantify your potential exposure?
   [ ] Very significant [ ] Significant [ ] Insignificant [ ] None [ ] Unknown
   Have you ever had any symptoms or signs (e.g. rash) which you attribute to tick bites? [ ] No [ ] Yes
   If "Yes", please describe:

_____

8. a. How would you rate the effectiveness of the health and safety procedures used for work?
   Check One [ ] Poor [ ] Fair [ ] Good [ ]Excellent
   b. Comments: _____

	YES	NO		YES	NO
9. Have you ever had an illness, condition or symptom which:			10. Have you ever developed illness or symptoms which you think were related to your work?	☐	☐
Occurred only during work?	☐	☐	11. Have you ever worked with a substance which made your nose, chest, or sinuses congested?	☐	☐
Occurred only after work, in evening?	☐	☐	12. Have you ever worked with substances that irritated your skin or caused a rash?	☐	☐
Occurred when you begin work after a weekend or holiday?	☐	☐			
Disappeared during vacations or weekends?	☐	☐			

	YES	NO
13. Would you like to talk to the healthcare professional who will review this questionnaire about your answers to this questionnaire?	☐	☐

STOP!: PHYSICIANS COMPLETE THE REMAINING SECTIONS.

PHYSICAL EXAMINATION AND SUPPORTING STUDIES

(Please initial on Authorization Form when completed)

HEIGHT _____inches **WEIGHT** _____lbs. **TEMP.** _____°F **BLOOD PRESSURE** _____/_____

PULSE (Resting) _____ /min.

For D.O.T. only: Pulse immediately after 2/min. exercise:_____

VISION Visual acuity (if applicant wears glasses, test and record both with and without glasses.)

NEAR	Left	Right	Both
Corrected	20/_____	20/_____	20/_____
Uncorrected	20/_____	20/_____	20/_____

FAR	Left	Right	Both
Corrected	20/_____	20/_____	20/_____
Uncorrected	20/_____	20/_____	20/_____

COLOR VISION

- Normal ☐
- Abnormal ☐
- Can recognize Red & Green ☐

PERIPHERAL VISION

- Normal ☐
- Abnormal ☐

URINALYSIS

Specified Gravity _____ Albumin_____ Female: LMP _____

Sugar _____ Blood _____

AUDIOGRAM (If marked YES on Exam Checklist):

	500	1000	2000	3000	4000	6000	8000
Right	_____	_____	_____	_____	_____	_____	_____
Left	_____	_____	_____	_____	_____	_____	_____

Note: Testing documentation must be forwarded to WorkCare

SPIROMETRY (If marked YES on Exam Checklist):

FVC _____ Observed Vol. FEV_1 _____ Observed Vol. $\frac{FEV_1}{FVC}$ _____%

FVC _____ Predicted %_____ FEV_1 _____ Predicted %_____

Note: Testing documentation must be forwarded to WorkCare

EKG (If marked YES on Exam Checklist);

☐ Normal ☐ Abnormal

Note: All EKG strips must be forwarded to WorkCare

CHEST X-RAY (If marked YES on Exam Checklist):

☐ Normal ☐ Abnormal

Comments: _____

SPECIMEN COLLECTION PER EXAM CHECKLIST

All laboratory specimens must be shipped by the day of the exam! If this is a Friday exam, mark Airbill for Saturday delivery. Exam data should be included for shipment in the box with the laboratory specimens.

MEDICAL EXAMINATION

CHECK LIST	NORMAL	ABNORMAL	DETAILED DESCRIPTION OF ABNORMAL FINDINGS
HANDS/SKIN			
HAIR	☐	☐	
SKIN COLOR/TEXTURE	☐	☐	
NAILS	☐	☐	
HEAD/EYES/EARS/NOSE/THROAT/MOUTH			
CONFIGURATION	☐	☐	
LIDS/CONJ/SCLERA	☐	☐	
PUPILS/FUNDI/EOM	☐	☐	
PINNA/CANALS/TM	☐	☐	
NASAL SEPTUM/MUCOSA	☐	☐	
TEETH/GUMS/TONGUE/PALATE	☐	☐	
NERVOUS SYSTEM			
CENTRAL	☐	☐	
MOTOR	☐	☐	
SENSORY	☐	☐	
CEREBELLAR	☐	☐	
REFLEXES	☐	☐	
NECK/NODES			
BRUIT	☐	☐	
ROM	☐	☐	
MUSCLE STRENGTH	☐	☐	
THYROID	☐	☐	
CERVICAL NODES	☐	☐	
INGUINAL/AXILLARY NODES	☐	☐	
CHEST/LUNGS			
SHAPES/SYMMETRY	☐	☐	
DIAPHRAGMATIC EXCURSION	☐	☐	
PERCUSSION	☐	☐	
AUSCULTATION	☐	☐	
CARDIOVASCULAR			
CAROTIDS	☐	☐	
NECK VEINS/PULSES	☐	☐	
HEART SOUNDS (MURMURS)	☐	☐	
HEART SIZE	☐	☐	
GASTRO/INTESTINAL			
LIVER	☐	☐	
SPLEEN	☐	☐	
MASSES	☐	☐	
TENDERNESS	☐	☐	
SCARS	☐	☐	
HERNIA	☐	☐	
MUSCULOSKELETAL/EXTREMITIES			
SPINAL ALIGNMENT	☐	☐	
EXTREMITIES	☐	☐	
(EDEMA, VARICOSITIES)	☐	☐	
JOINTS	☐	☐	
ROM	☐	☐	

COMMENTS:

EXAMINING PHYSICIAN (PRINT)	PHYSICIAN SIGNATURE	DATE

SUMMARY OF FINDINGS AND COMMENTS RELEVANT TO ABNORMAL CONDITIONS

_____

_____

_____

_____

_____

_____

_____

Signature of Licensed Examining Physician:_____

Printed Name:_____

Phone: (_____)_____

INSTRUCTION FOR PHYSICIAN/CLINICIAN

1. The results of the required testing should be recorded on page 10.

2. Please be sure to note EKG and chest x-ray readings on NORMAL or ABNORMAL on page 10 if **required for this exam.**

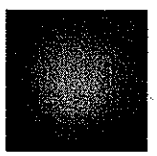
3. Please review any YES answers ONLY for questions on pages 4, 5, 7, 8 and 9 of this booklet.

You are not required to review the other history questions.

4. Your physical examination findings should be recorded on page 11.

5. The booklet and any specimens must be shipped to our laboratory **THE DAY OF THE EXAM.**

QUESTIONS? CALL *WorkCare* 1-800-455-6155



WORKCARE™

Transforming Occupational Health

1-(800) 455-6155

URS	Health, Safety and Environment **MEDICAL SURVEILLANCE EVALUATION**	Attachment 24-2

This information will be used to determine routine medical screening exams for employees who work outside of an office setting. In addition, Site Health and Safety Plans may specify project related medical surveillance for regulated substances.

Please answer each question.

Date:	
Name:	
Phone # ( )	
SSN#	
Employee #	
Job Title	
Location:	Supervisor:
H&S Representative:	
Division	Region/Business Unit:

Choose One:

( ) New Employee	( ) Current employee with job change
( ) Transfer from	OFFICE

The following questions assess federally mandated medical screenings and surveillance requirements:

	Yes	No
Respirator		

ERROR: undefined
OFFENDING COMMAND:

STACK:

-savelevel-

URS

Health, Safety and Environment

Medical Screening and Surveillance Exam Protocol

Attachment 24-3

PROTOCOL	HAZWOPER Baseline or Preassignment Baseline	HAZWOPER Annual or Biennial	HAZWOPER Exit	DOT Driver Certification (Baseline and Biennial)	ASBESTOS (Baseline, Annual and Exit)	MINI-RESPIRATOR (Baseline and Biennial)
Medical History & Respiratory Questionnaire	X	X	X	X	X	X
OSHA Asbestos Questionnaire (Initial or Periodic)					X	
Medical Exam	X	X	X	X	X	If indicated by questionnaire
Physical Exam (height, weight, pulse, oral temperature, blood pressure)	X	X	X	X	X	
Non-resting pulse				X		
Vision	X	X	X	X	X	
Urinalysis	X	X	X	X		
Audiogram (hearing test)	X	X	X	X	(If indicated by project noise levels)	
Spirometry (pulmonary function test)	X	X	X		X	X
Electro-cardiogram (EKG)						
EKG Age < = 40	X	Every 3 years for annual, every 4 years for biennial				
EKG Age 41-55	X	Every 2 years				
EKG Age 56+	X	Every year for annual, every 2 years for biennial				
Chest x-ray (one view)						
Age < or = 40	X	Every 4 years	If symptomatic or due on periodic		Baseline and every 5 years per OSHA 1910.1001	
Age 41-50	X	Every 3 years for annual, every 4 years for biennial	If symptomatic or due on periodic		Baseline and every 2-5 years per OSHA 1910.1001	
Age 51-54	X	Every 2 years	If symptomatic or due on periodic		Baseline and every 2-5 years per OSHA 1910.1001	
Age 55+	X	Every year for annual, every 2 years for biennial	If symptomatic or due on periodic		Baseline and every 1-5 years per OSHA 1910.1001	
B-reader					X	
Complete Blood Count with White Cell Differential	X	X	X			
Blood Chemistry Panel	X	X	X			

***Note: Additional entry, periodic, and exit biological monitoring or toxicological screening may be indicated in the project-specific health & safety plan. Examples include: blood lead/ZPP, serum/RBC cholinesterase, urine heavy metals (arsenic, cadmium, mercury, chromium, or beryllium), urine radiation (thorium, uranium), biological vaccinations (hepatitis B, hepatitis A), blood benzene, blood beryllium LPT, etc.**

URS SAFETY MANAGEMENT STANDARD
Noise and Hearing Conservation

1. Applicability

This procedure applies to URS Corporation facilities and field operations where URS Corporation personnel may encounter noise exposures that may exceed 85 dBA as an 8 hour Time Weighted Average.

2. Purpose and Scope

The purpose of this procedure is to protect employees from hazardous noise exposures and to prevent hearing loss.

3. Implementation

Office/Lab locations:	High noise is unlikely to be encountered at URS offices, however, if applicable, the implementation of this program is the responsibility of the Office Manager.
Field Activities:	Implementation of this program is the responsibility of the Project Manager.

4. Requirements

A. General

The use of hearing protectors in any location where powered or motorized equipment or any other noise source could reasonably be expected to exceed 85 dBA. Use of hearing protectors may only be discontinued when noise levels are verified to be less than 85 dBA through a properly conducted noise survey. Whenever information indicates that any employee's exposure may equal or exceed an 8-hour time-weighted average of 85 decibels, the project manager or location manager will be responsible to enforce the proper use of hearing protectors.

B. Hearing Protectors

1. Require that at least two (2) types of hearing protectors are available to employees free of charge, preferably a plug and a muff type.

2. Minimum Noise Reduction Ratings (NRR)

Hearing protectors issued must have the following minimum NRR:

Ear Plug	Muffs
29 dBA	27 dBA

3. Require that hearing protectors are used and thus effectively protect hearing.

C. Noise Surveys

1. Noise surveys must be conducted in a manner that reasonably reflects the exposure of the affected employees. Surveys must be conducted under the supervision of a URS Safety Program Representative.

2. Sound level meters and audio dosimeters used to determine employee exposure to noise sources must be Type II (accurate to within +/- 2 dBA), operated in "slow" response, on the "A" scale, and be calibrated to factory guidelines (including periodic factory recalibration).

D. Noise Controls

Eliminate noise sources to the extent possible. Examples of controls that must be considered follow:

1. Addition or replacement of mufflers on motorized equipment.

2. Addition of mufflers to air exhausts on pneumatic equipment.

3. Following equipment maintenance procedures to lubricate dry bearings.

4. Isolation of loud equipment with newer and quieter models.

E. Audiometric Exams

1. Tests

Details on the medical surveillance program (including audiometric testing) are included in SMS 24.

Audiometric tests shall be performed by a person meeting OSHA's 1910.95 (g)(3)'s definition. Within 6 months of an employee's first exposure at or above the action level, a valid baseline audiogram shall be established against which subsequent audiograms can be compared. Testing to establish a baseline audiogram shall be preceded by 14 hours without exposure to noise. Hearing protectors may be used as a substitute for the requirement that

baseline audiogram shall be preceded by 14 hours without exposure to workplace noise. The medical surveillance provider shall notify employees of the need to avoid high levels of non-occupational noise exposure during the 14-hour period immediately preceding the audiometric examination. For multi-year projects, an annual audiogram shall be obtained for each employee exposed at or above an 8-hour time-weighted average of 85 decibels.

Each employee's annual audiogram shall be compared to that employee's baseline audiogram to determine if the audiogram is valid and if there is a standard threshold shift (STS). If the annual audiogram shows that an employee has suffered a standard threshold shift, the employer will obtain a retest within 30 days and consider the results in assessing an STS as the annual audiogram. The audiologist, otolaryngologist, or physician shall review problem audiograms and shall determine whether there is a need for further evaluation. If an STS has occurred, the medical surveillance provider will notify the employee within 21 days of the determination.

2. Standard Threshold Shifts

   If an employee's test results show a confirmed STS, their hearing protection will be evaluated and refitted, and a medical evaluation may be required.

F. Training

Verify that each employee who must work in a noisy environment is current on the required Hearing Conservation Training. Training must include the following topics:

1. The effects of noise on hearing.
2. The purpose of hearing protectors.
3. The advantages and disadvantages of various types of hearing protectors.
4. The attenuation of various types of hearing protection.
5. The selection, fitting, care, and use of hearing protectors.
6. The purpose of audiometric testing.

7. An explanation of the audiometric testing procedure.

5. Documentation Summary

A. File these records in the Office Safety Filing System:

1. Noise surveys, when applicable.
2. Training Records.

B. File noise surveys, when applicable, in the Project Safety File:

6. Resources

A. U.S. OSHA Standard – Occupational noise exposure – 29 CFR 1910.95

B. U.S. OSHA Construction Standard – Occupational noise exposure – 29 CFR 1926.52

C. U.S. OSHA Technical Links - Noise and Hearing Conservation

D. American Industrial Hygiene Association: The Occupational Environment – Its Evaluation and Control, Chapter 20. Fairfax, VA: 1997

E. National Hearing Conservation Association web site

F. URS SMS 24 Medical Screening and Surveillance

URS SAFETY MANAGEMENT STANDARD
Sanitation

1. Applicability

This procedure applies to URS field operations.

2. Purpose and Scope

The purpose of this program is to provide employees on field assignments with appropriate personal hygiene facilities, including toilets, wash rooms and eating facilities, and to protect employees from unsanitary conditions.

3. Implementation

Field Activities - Implementation of this program is the responsibility of the Project Manager.

4. Requirements

A. Arrange for the installation of adequate toilet and wash facilities during the planning stage of field projects. Note: Mobile crews having transportation readily available to nearby toilet facilities need not be provided with facilities.

1. Provide job sites without sanitary sewer with one of the following:

   a. Privies (where their use will not contaminate ground or surface water).

   b. Chemical toilets.

   c. Combustion toilets.

2. Provide toilets for employees of each sex at field sites according to the following ratio:

Number of Employees	Minimum # of water closets (1)
1 - 15	1
16 - 25	2
36 - 55	3
56 - 80	4
81 - 110	5
111 - 150	6
Over 150	(2)

***Footnote (1)** where toilet facilities will not be used by women, urinals may be provided instead of the minimum specified.*
***Footnote (2)** 1 additional fixture for each additional 40 employees.*

B. Provide a means for washing hands next to toilet areas.

C. Arrange for fresh potable water to be available.

1. Fixed Facilities

   Require backflow prevention devices, testing and administrative controls to be used for all potable water supply branches.

2. Field Sites

   a. Require an adequate supply of potable water to be available.

   b. Water containers must be tightly closed and marked as to the contents. Containers must have a tap and be refilled daily.

D. Maintain existing toilet and wash facilities.

1. Maintain toilets and toilet area in good repair and in a clean and sanitary condition.

2. Provide paper towels and soap or other suitable sanitizing material for washing hands.

3. Locate hand-washing facilities next to or near toilets.

E. Maintain availability and cleanliness of drinking water.

1. Maintain backflow devices in a sanitary condition.

2. Water coolers and water dispensers are to be kept in a sanitary condition and filled only with potable water.

3. Provide fountain-type dispensers or one-use cups at each water dispenser.

F. Maintain lunchrooms in a clean condition.

1. Require microwave ovens to be used for food only.

2. Require refrigerators that are designated for food storage to be used for food only.

3. Do not allow workers to eat or store foods in areas where toxic materials are handled or stored.

4. Periodically clean lunchrooms.

G. Manage waste generated on site.

1. Release sanitary sewage into sanitary sewer lines or to other proper disposal channels.

2. Do not discharge hazardous waste into the sanitary sewer or storm sewer system.

3. Collect garbage and trash daily.

a. Garbage containers located outside buildings should have lids and remained closed. Transport garbage offsite at least weekly.

b. At remote field sites where bears and similar wild animals are a hazard, remove garbage from the site daily (do not let garbage remain on site overnight).

H. Prevent pests and vermin from multiplying on site. Eliminate unsanitary conditions that propagate insects or vermin.

I. Inspect work sites using checksheet provided as Attachment 30-1 for compliance at the beginning of the project and mid -project.

5. Documentation Summary

File completed inspection sheets in the Project Safety File.

6. Resources

A. U.S. OSHA Construction Standard - Sanitation - 29 CFR 1926.51

B. U.S. OSHA General Industry Standard - Sanitation - 29 CFR 1910.141

C. National Interim Primary Drinking Water Regulations 40 CFR 141

The following documents are PDF files which must be read with Adobe Reader

D. Attachment 30-1 - Sanitation Inspection Checksheet

E. Queensland Workplace Health and Safety - Code of Practice for Construction Project Amenities

URS	Health, Safety and Environment **SANITATION INSPECTION SHEET**	Attachment 30-1

Location: _____ **Job No:** _____

Date Inspected: _____ **Name of Inspector:** _____

Note: All "No" notations must be corrected		**Yes**	**No**
	Toilets		
1.	Are there an adequate number of toilets on site? 1 – 15 employees = 1 toilet 16 - 35 employees = 2 toilets 36 – 55 employees = 3 toilets 56 – 80 employees = 4 toilets 81 - 110 employees = 5 toilets		
2.	Toilets are in clean condition.		
3.	Toilet paper is provided.		
4.	Toilet areas are clean and sanitary.		
	Hand Washing Facilities		
5.	Hand washing facilities are provided near toilets.		
6.	Paper towels and soap are provided.		
	Drinking Water		
7.	Drinking water is provided on site.		
8.	Disposable cups are provided or fountain type dispenser is provided.		
9.	Drinking water containers are kept clean and tightly closed or covered.		
	Lunch Rooms		
10.	Lunch rooms or eating areas are kept clean.		
11.	Microwaves are used for food only.		
12.	Microwave ovens are kept clean.		
13.	Refrigerators are kept clean.		
14.	Refrigerators are used to store food only.		
	Vermin		
15.	Rats, mice and other vermin are not living within buildings.		
16.	Cockroaches and fleas are not thriving within buildings.		

REMARKS:

_____

_____

_____

_____

URS SAFETY MANAGEMENT STANDARD
Utility Clearances And Isolation

1. Applicability

This procedure applies to URS projects where personnel may encounter subsurface or overhead utilities.

2. Purpose and Scope

Many field activities are conducted near aboveground and underground utilities. The primary purpose of this Standard is to establish operating requirements that will permit employees to work safely in the vicinity of electrical, natural gas, fuel, water, and other utility systems and installations. The secondary purpose is to prevent economic damage to utility systems from operations associated with project-related activities.

The term "utility clearance" includes

A. The positive locating of utility systems in or near the work area.

B. A signed statement by an appropriate representative attesting to the location of underground utilities and/or the positive de-energizing (including lockout) and testing of electrical utilities.

Note that in some cases, utility representatives may deem it appropriate or necessary to use insulating blankets to isolate a power line; this is an acceptable alternative to positive de-energizing (only utility representatives can make the determination).

"Contact" with overhead power lines is considered to occur when equipment is closer to power lines than permitted by the criteria in the table in Section 4.0.C.2.b below. (See note for U.K. operations).

3. Implementation

Field Operations - Implementation of this procedure is the responsibility of the Project Manager.

4. Requirements

A. Time for Completion

Complete utility clearances prior to the start of any work in the area of the utility that could feasibly result in contact with or damage to that utility.

B. Local Regulations

Research local codes and regulations regarding utility locating and isolation requirements. Utility companies and locating services are among the appropriate resources.

C. Overhead Power Lines

1. Proximity to Power Lines

   No work is to be conducted within 50 feet (15 meters) of overhead power lines without first contacting the utility company to determine the voltage of the system. No aspect of any piece of equipment is to be operated within 50 feet (15 meters) of overhead power lines without first making this determination.

2. Operations adjacent to overhead power lines are **PROHIBITED** unless one of the following conditions is satisfied:

   a. Power has been shut off, positive means (such as lockout) have been taken to prevent the lines from being energized, lines have been tested to confirm the outage, and the utility company has provided a signed certification of the outage.

   b. The minimum clearance from energized overhead lines is as shown in the table below, or the equipment will be repositioned and blocked so that no part, including cables, can come within the minimum clearances shown in the table.

MINIMUM DISTANCES FROM POWERLINES	
Powerlines Nominal System kV	Minimum Required Distance
0-50	10 feet (3 meters)
51-100	12 feet (3.6 meters)
101-200	15 feet (4.6 meters)
201-300	20 feet (6.1 meters)
301-500	25 feet (7.6 meters)
501-750	35 feet (10.7 meters)
751-1000	45 feet (13.7 meters)

Note: for U.K. operations, the specific safe distance is determined by the utility company.

   c. The power line(s) has been isolated through the use of insulating blankets which have been properly placed by the utility. If insulating blankets are used, the utility will determine

the minimum safe operating distance; get this determination in writing with the utility representative's signature.

3. All inquiries regarding electric utilities must be made in writing and a written confirmation of the outage/isolation must be received by the Project Manager prior to the start of work.

D. Underground Utilities

1. Do not begin subsurface work (e.g., trenching, excavation, drilling, etc.) until a check for underground utilities and similar obstructions has been conducted. The use of as-built drawings must be confirmed with additional geophysical or other survey.

2. Contact utility companies or the state/regional utility protection service at least two (2) working days prior to excavation activities to advise of the proposed work, and ask them to establish the location of the utility underground installations prior to the start of actual excavation.

3. Obtain utility clearances for subsurface work on both public and private property. Clearances are to be in writing, signed by the party conducting the clearance.

4. Protect and preserve the markings of approximate locations of facilities until the markings are no longer required for safe and proper excavations. If the markings of utility locations are destroyed or removed before excavation commences or is completed, the Project Manager must notify the utility company or utility protection service to inform them that the markings have been destroyed.

5. Do not conduct mechanical-assisted subsurface work (e.g., powered drill rig, mechanical excavator, etc.) within five (5) feet (1.5 meters) of a confirmed or suspected utility or other subsurface structure. Confirm minimum distances for mechanical-assisted subsurface work with the utility owner, as distances beyond this five foot minimum may be required.

6. Subsurface work within five feet (1.5 meters) of a confirmed or suspected utility or other subsurface structure must be done by hand (e.g., hand auger, shovel) to the point where the obstruction is visually located and exposed. Once the obstruction location is confirmed in this manner, mechanical-assisted work may commence.

7. Reference SMS 13, "Excavation Safety" for additional information regarding subsurface operations.

E. Training

Conduct a site briefing for site employees regarding the hazards associated with working near the utilities and the means by which the operation will maintain a safe working environment. Detail the method used to isolate the utility and the hazards presented by breaching the isolation.

5. Documentation Summary

File these records in the Safety Filing System:

1. Documents requesting utility clearance.
2. Documents confirming utility clearance.
3. Training/briefing documentation of each isolation.

6. Resources

1. Utility Locating Services (typically under "Utility" in the Yellow Pages)
2. NIOSH Alert - Preventing Electrocutions from Contact Between Cranes and Power Lines
3. One Call Utility Locating List
4. National Utility Locating Contractor's Association
5. U.K. - Health and Safety Executive GS6

   The following documents are PDF files which must be read with Adobe Reader:

6. Queensland Workplace Health and Safety - Underground Services Health and Safety Guide

URS SAFETY MANAGEMENT STANDARD
Respiratory Protection

1. Applicability

This program defines responsibilities and procedures and is applicable to URS operations that may require the use of respiratory protection including Immediately Dangerous to Life and Health (IDLH) and emergency conditions. This program also addresses the voluntary use of respirators.

2. Purpose and Scope

The purpose of this procedure is to protect those employees performing operations for which exposures can not be controlled by use of conventional engineering or administrative controls and prior to establishing a negative air exposure assessment, and to require that respiratory protective equipment is selected, used, maintained, and stored in accordance with acceptable practices.

3. Implementation

Laboratory/Office/Shop Locations -	Implementation of this program is the responsibility of the Office Manager.
Field Activities -	Implementation of this program is the responsibility of the Project Manager.
Program Administration-	URS Health and Safety Director is responsible for the development and annual review of this program.

URS Health and Safety Program Representatives are responsible to:

Assist responsible employees in the implementation of the program.

Assessing local compliance with the program.

4. Requirements

A. Determine if respirators are needed or going to be used for hazardous jobs before assigning that job to an employee.

1. If the determination is that a potential for respiratory hazards exists with any portion of that job activity then, complete Attachment 42-1.

2. Contact a URS Health and Safety Program Representative if any of the questions in Attachment 42-1 are checked "yes."

3. Follow instructions in Attachment 42-2 for employees who wish to voluntarily use dust masks.

4. Follow all the requirements of this procedure for employees who wish to voluntarily use tight-fitting (e.g., air purifying) respirators.

5. Required respirators will be paid for by URS and will be provided without cost to the employee.

B. Select the proper respirator for the job.

1. For those jobs identified in Attachment 42-1, contact a URS Health and Safety Program Representative for assistance in respirator selection.

2. Contact a URS Health and Safety Program Representative for follow up if there are any problems implementing the recommendations made.

C. Require employees who will use respirators to be medically qualified before fit testing and assigning them a respirator.

1. For program details, refer to SMS 24, Medical Screening and Surveillance.

2. Require that employees have a current and accurate Medical Surveillance form (Attachment 24-2)

3. Obtain a copy of the employee's Health Status Medical Report from the Health and Safety Representative. The consulting occupational physician of the medical service provider following each work related examination issues the Health Status Medical Report. Employees cannot be assigned respirators unless they are medically cleared for respirator use.

D. Require respirator users to receive appropriate training.

1. All respirator users must be trained:

a. Before they are assigned a respirator.

b. Annually thereafter.

c. Whenever a new hazard or job is introduced.

d. Whenever employees fail to demonstrate proper use or knowledge.

2. Training must address, at a minimum, the following:

a. Why the respirator is necessary, and what conditions can make the respirator ineffective.

b. What the limitations and capabilities of the respirators are.

c. How to use respirators effectively in emergency situations.

d. How to inspect, put on and remove, and check the seals of the respirator.

e. What the respirator maintenance and storage procedures are.

f. How to recognize medical signs and symptoms that may limit or prevent effective use of the respirator.

E. Require respirator users to be fit tested.

1. Any employee who has been assigned a reusable respirator must be fit tested on an annual basis (no more than one year may elapse between fit tests), or when the employee is assigned a respirator of a different make, type or size from that previously tested.

2. Fit testing can be performed by contract or in house personnel.

3. Obtain a signed written copy of the fit test results. The fit test results should include:

a. Employee's name and social security number.

b. Respirator brand, model and size fitted for.

c. Date fit tested.

d. Method of fit testing used.

e. Name and signature of fit tester.

f. Statement that fit test protocol met the requirements of 29 CFR 1910.134.

g. Manufacturer and serial number of fit testing apparatus.

A fit test results form is available at Attachment 42-5.

F. Provide qualified employees with respirator(s) and adequate amounts of parts and cartridges.

1. Assign employees whose duties require respirators their own respirator for which they have been fit tested.

2. Provide special eyeglass inserts designed for the respirator if an employee must wear eyeglasses with a full facepiece respirator. Contact lenses may be worn when wearing a full facepiece respirator.

G. Require respirators to be used properly.

1. Prohibit facial hair where the respirator-sealing surface meets the wearer's face.

2. Require employees to perform a positive and negative fit check every time the respirator is put on.

3. Employees will leave the area where respirators are being used:

a. Before removing the facepiece for any reason.

b. To change cartridges.

c. If any of the following is detected:

1. Vapor or gas breakthrough.

2. Leakage around the facepiece.

3. Changes in breathing resistance.

4. Use cartridges with End of Service Life Indicators or determine the respirator cartridge changeout schedule. See Attachment 42-4 for Guidance.

H. Require respirators to be cleaned and stored properly.

1. Clean and disinfect respirators after each use.

2. Store respirators in a plastic bag or case and in a clean location.

3. Inspect respirators before use and after each cleaning.

I. Address issues associated with special use respirators self-contained breathing apparatus; air supply respirators; emergency use respirators).

1. Self Contained Breathing Apparatus

   Inspect self-contained breathing apparatus and other emergency use respirators monthly and after each use in accordance with manufacturer's instructions.

2. Air Supplied Respirators

   a. Air used for atmosphere-supplying respirators must meet or exceed the requirements for Type 1 - Grade D breathing air. Never use oxygen.

      1. A certificate of analysis must accompany bottled air.

      2. Compressors used to supply breathing air must:

         i. Prevent entry of contaminated air into the air supply.

         ii. Minimize moisture content.

         iii. Have suitable in-line sorbent beds and filter to provide appropriate air quality.

         iv. Have a high carbon monoxide alarm that sounds at 10 ppm.

   b. Couplings on air hose lines must be incompatible with other gas systems.

J. Require follow up training and medical surveillance to be provided as directed.

1. Provide follow-up physical examinations as directed by the SMS 24-3, Medical Screening and Surveillance Exam Protocol table.

2. Provide follow-up physicals as directed by the Regional Medical Surveillance Administrator.

3. Provide annual refresher training.

4. Provide annual fit testing.

5. Documentation Summary

A. Laboratory

1. File these records in the Laboratory Safety Filing System

   a. Completed forms:

      1. "Identifying When A Respirator Is Needed" - Attachment 42-1; and,

      2. "Respirator Standard Operating Procedure" - Attachment 42-3.;

   b. Employee Health Status Medical Report includes clearance for respirator use.

   c. Employee Fit Test Records; and,

   d. Employee Respirator Training Records.

2. Send a copy of the following records to the Regional Health and Safety Manager:

   a. Completed "Voluntary Use of Respirators" form - Attachment 42-2.

   b. Employee Fit Test Records.

   c. Employee Respirator Training Records.

B. Field

1. File these records in the Project Health and Safety File:

   a. Completed forms:

      1. "Identifying When A Respirator Is Needed" - Attachment 42-1; and,

2. "Respirator Standard Operating Procedure" - Attachment 42-3.
3. Employee Health Status Medical Report includes clearance for respirator use.;
4. Employee Fit Test Records; and,
5. Employee Respirator Training Records.

2. Send a copy of the following records to the Regional Health and Safety Manager:
   a. Completed "Voluntary Use of Respirators" form - Attachment 42-2;.
   b. Employee Fit Test Records; and,
   c. Employee Respirator Training Records.

6. Resources

A. U.S. OSHA Standard - Respiratory Protection - 29 CFR 1910.134

B. U.S OSHA Technical Links - Respiratory Protection

C. ANSI Z88.6, Respirator Use – Physical Qualifications for Personnel, Current Revision

D. ANSI Z88.2, Respiratory Protection, Current Revision

E. 3M Cartridge Service Life Interactive Program

F. Australian Standards AS/N25 1715 - 1994. Selection, Use, and Maintenance of Respiratory Protection Devices

G. Australian Standards HB9-1994. Occupational Personal Protection

H. AIHA, The Occupational Environment - Its Evaluation and Control

The following documents are PDF files which must be read with Adobe Reader:

I. NIOSH Respirator Decision Logic

J. NIOSH Guide to Industrial Respiratory Protection

K. Attachment 42-1 - Identifying When a Respirator is Needed

L. Attachment 42-2 - Voluntary Use of Respirators

M. Attachment 42-3 - Respirator Standard Operating Procedure

N. Attachment 42-4 - Respiratory Cartridge Change Schedule

O. Attachment 42-5 - Fit Test Results Form

P. Medical Screening and Surveillance Program - SMS 24

URS Corporation

URS Corporation Health & Safety Program
IDENTIFYING WHEN A RESPIRATOR IS NEEDED

Site Location:_____ **Date:**_____

Name of Person Performing Evaluation:_____

Project:_____

Answer the questions below for the jobs you are to perform on site. If a "yes" response is checked, consult with a URS Corporation Health and Safety Professional to determine:

- ***if a respirator is truly needed for the job, as well as,***
- ***the type of respirator needed for the job.***

MATERIAL USED OR PROCESS TO BE PERFORMED	YES Respirator may be needed	NO	NOTES
Abrasive Blasting • Abrasive blasting (with any type of grit or material) will be performed. • Employee will fill abrasive blasting pots or perform clean-up activities. • Employee will be in a contained area where abrasive blasting is taking place.			
Acids • Liquid or powder acids will be used in a situation where acid vapors, mists or dust may be breathed.			
Adhesives • Aerosol-propelled adhesives are to be used in areas where there is no or insufficient local exhaust ventilation. • Two-part adhesives (mix part one with two, let set then use) are to be used in areas where there is limited ventilation.			
Alkalis/Bases/Caustics • Powdered alkalis will be used in a situation where an airborne dust may be breathed.			
Asbestos Abatement • Asbestos will be removed, repaired or sampled. • Employees will be inspecting or overseeing areas where asbestos will be removed or disturbed.			

MATERIAL USED OR PROCESS TO BE PERFORMED	YES Respirator may be needed	NO	NOTES
Cleaning Compounds • Degreasers or carbon removers will be used in areas where local exhaust ventilation is not provided. • Aerosol propelled cleaning compounds will be used in areas where there is no local exhaust ventilation. • Degreasers or carbon removers will be used in voids, tanks, or other confined spaces.			
Corrosion Preventive Compounds • Corrosion prevention compounds, including chemical conversion compounds and corrosion inhibitors, will be used in areas where there is no local exhaust ventilation.			
Detergents/Soaps • Ammonia based detergents will be used in large quantity (more than five gallons) in areas where local exhaust ventilation cannot be provided. • Large quantities (5 or 55 gallon containers) of high pH powder detergent/soap will be used in a situation where dust may be breathed.			
Fuels (including regular or unleaded gasoline, kerosene, diesel fuel, JP-5) • Employees will be inside unventilated fuel cells or other confined spaces containing fuels.			
Grinding, Cutting, Sanding • Cutting, grinding or sanding surfaces that have coatings containing lead, cadmium, chromium, zinc or beryllium. • Cutting, grinding or sanding surfaces that are concrete or glass without use of ventilation or water.			
Hazardous Waste Sites • Employees will be performing tasks on a hazardous waste site that requires the use of respirator (as indicated in the site safety & health plan). • Employees will be performing site assessments on potential hazardous waste sites.			
Hydraulic Fluids (including petroleum-based fluids, synthetic fire-resistant fluids, and water based fire resistant fluids) • Hydraulic fluids and the vapors generated will not be exhausted using local exhaust ventilation. • Synthetic fire-resistant fluids or water-based fire-resistant fluids will be used in an area where the air is contaminated with visible mist or spray from hydraulic fluids.			

MATERIAL USED OR PROCESS TO BE PERFORMED	YES Respirator may be needed	NO	NOTES
Inspection Penetrants (including Flouro-finder, water indicating pastes, and penetrant removers) • An aerosol-propelled inspection penetrant will be used in an area where local exhaust ventilation cannot be provided, or in a situation where the solvent vapors can be breathed.			
Lead Abatement Activities • Lead containing materials will be disturbed, removed or sampled. • Employees will be inspecting or overseeing areas were lead will be removed or disturbed.			
Lubricants/Oils • Aerosol lubricants/oils will be sprayed with no immediate exhaust ventilation.			
Oxidizers (materials that give off oxygen including chlorine laundry bleach, calcium hypochlorite, calcium oxide, oxygen candles, lithium hydroxide, hydrogen peroxide, and sodium dichromate) • Oxidizers containing organic chlorine will be used in a situation where the dusts/vapors may be breathed. • Powdered oxidizers will be used in a situation where airborne dust may be breathed.			
Paint Materials (including paints, primers, thinners, enamels, lacquers, strippers, coatings and varnishes) • Paint materials will be spray applied in areas where there is no local exhaust ventilation. • Two part (mix part a with part b, let set, then apply) polyurethane or epoxy polyamide paints will be brush or spray applied. • Paints containing lead, chromium, cadmium, beryllium, and zinc (refer to the MSDS). • Paint materials will be applied in confined spaces.			
Solvents (including hydrocarbon solvents such as acetone, methyl ethyl ketone, toluene, xylene, and alcohols, as well as mixed solutions like antifreeze, heat transfer fluid, turpene, dope and naphtha thinner) • Local exhaust ventilation will not be provided and work will involve breathing solvent vapors. • Solvents will be used within confined spaces. • Solvents will be applied using aerosols.			
Thermal Insulation (including asbestos & non-asbestos materials like pipe lagging, fiberglass insulation, boiler insulation, packing materials and floor/ceiling tiles) • Insulation will be disturbed, removed or sampled.			

MATERIAL USED OR PROCESS TO BE PERFORMED	YES Respirator may be needed	NO	NOTES
Water Treatment Chemicals (includes corrosive chemicals such as tri-sodium phosphate, hardness buffer, tritrating solution, morpholine, caustic soda, citric acid and nitric acid as well as toxic chemicals such as mercuric nitrate, hydrazine, EDTA and sodium nitrate) • Morpholine, EDTA, or harness buffer/titrating solution is to be used in poorly ventilated spaces. • Powdered water treatment chemicals will be used in a situation where chemical dusts may be breathed.			
Welding/Brazing • Welding will be performed in confined spaces. • Welding galvanized metal or stainless steel. • Brazing with cadmium or lead.			
For Any of The Above Listed Activities • A employee will be in the immediate area - within 10 feet of the job or operation, or • Employee will be inside confined space where activities are taking place, or • Employee will be inside a "controlled area" such as found in asbestos abatement, lead abatement, radiation control area, or a hazardous waste site.			
Material Safety Data Sheets • For any chemical product used, a respirator is recommended.			
Product Labels • For any chemical or process that indicates respirators should be used.			
Product Use Instructions For any product used, instructions indicate a respirator should be used.			
Standard Operating Procedures A Standard Operating Procedure indicates the use of a respirator.			

URS	Health, Safety, and Environment **VOLUNTARY USE OF RESPIRATORS**	Attachment 42-2

Instructions: Have the employee that is opting to use a respirator for non-overexposure conditions read this page, and then sign on the bottom of the page. Maintain a copy in the employee's training file.

Respirators are an effective method of protection against designated hazards when properly selected and worn. Respirator use is encouraged, even when exposures are below the exposure limit, to provide an additional level of comfort and protection for employees. However, if a respirator is used improperly or not kept clean, the respirator itself can become a hazard to the employee. Sometimes employees may wear respirators to avoid exposures to hazards, even if the amount of the hazardous substance does not exceed the limits set by OSHA standards. If your employer provides respirators for your own voluntary use, or if you provide your own respirator, you need to take certain precautions to be sure that the respirator itself does not pose a hazard.
You should do the following

1. Read and follow all instructions provided by the manufacture on use, maintenance, cleaning and care, and warnings regarding the respirators limitations.
2. Choose respirators certified for use to protect against the contaminant of concern. NIOSH, the National Institute for Occupational Safety & Health of the U.S. Department of Health and Human Services, certifies respirators. A label or statement of certification should appear on the respirator or respirator packaging. It will tell you what the respirator is designed for and how it will protect you.
3. Do not wear your respirator into atmospheres containing contaminants for which your
4. Respirator is not designed to protect you against. For example, a respirator designed to filter dust particles will not protect you against gases, vapors, fumes, smoke or very small solid particles.
5. Keep track of your respirator so that you do not mistakenly use someone else's respirator.
6. If you have any health conditions (asthma; high blood pressure; emphysema; heart disease) that could be aggravated by using a respirator, you should check with your doctor before using one.

I have read and understand this information on:	Date:

Employee's Name (Please Print)
Employee's Signature

URS	Health, Safety, and Environment **RESPIRATOR STANDARD OPERATING PROCEDURE**	Attachment 42-3

Job Task Reviewed:
Date Reviewed
Task Review by:

ADMINISTRATIVE PROCEDURES

1. All respirator users must be medically qualified to use respirators.
2. Respirator users must be trained annually in respirator use and fit tested annually.
3. Only the person to whom it was issued will use respirator.
4. Persons using glasses who are required to use a full-face respirator may use contact lenses or eyeglass inserts designed for the respirator.

GUIDANCE FOR SELECTION OF RESPIRATOR & CARTRIDGES/FILTERS

1. Respirators are currently being issued and used for the following job activity:

2. The respirator will be equipped with the following cartridges/filters:

3. Filters are to be changed when the breathing resistance increases.

4. Cartridges are to be changed _____ or when the contaminant you are protecting yourself from can be smelled or tasted.

FIT TESTING & FIT CHECKING

1. Fit testing is required annually. To arrange for fit testing, call your local safety representative.
2. Respirator users will "fit check" the respirator every time the respirator is put on:

   Negative Check – cover filters/cartridges with palms of hands and breath in, leakage should not be detected around the face seal of the respirator. Do not use if leakage is detected.

   Positive Check – cover the exhalation valve cover with palm of hand and blow out slightly, leakage should not be detected around the respirator seal.

   For Air Supply Respirators – kink or close off air supply hose and breath in, leakage should not be detected around the face seal of the respirator.

CLEANING & MAINTENANCE OF RESPIRATOR

1. Clean and disinfect respirator after every use.
2. Inspect respirator after every day in use to ensure parts are not missing. Replace missing parts from stock supply.
3. Store clean respirator in labeled plastic bag out of direct sunlight.
4. Do not alter respirator in any way.

URS	Health, Safety, and Environment **RESPIRATOR CARTRIDGE CHANGE SCHEDULE**	Attachment 42-4

A cartridge change schedule must be developed for cartridges or canisters used with air purifying respirators that do not have an End of Service Life Indicator (ESLI). The purpose of this is to prevent contaminants from breaking through the respirator's sorbent cartridge(s), and thereby over-exposing employees. NIOSH has approved ESLIs for only four cartridges or canisters (mercury vapor, carbon monoxide, ethylene oxide, and hydrogen sulfide). Historically we have relied on the warning properties (odor, irritation) of a contaminant to dictate cartridge change. OSHA no longer allows this as the sole basis for changing respirator cartridges. In developing a change schedule the following factors should be considered:

Contaminants.
Concentration.
Frequency of use (continuously or intermittently throughout the shift).
Temperature and humidity.
Work rate.
The presence of potentially interfering chemicals.

The worst-case conditions should be assumed to avoid early breakthrough. This must be documented in the project health and safety plan or, in the cases of office or labs, in the site specific Respiratory Protection Program.

Sources of Help

Manufacturers

3M has an interactive "Cartridge Service Life" program that can be downloaded for free:
http://www.mmm.com/market/safety/ohes2/index.html

This program will estimate cartridge service life for 3M products against many contaminants. The program does not evaluate the service life against mixtures (multiple contaminants). Because of the complexity in evaluating mixtures, OSHA offers the following guidance:

> When the individual compounds in the mixture have similar breakthrough times (i.e., within one order of magnitude), service life of the cartridge should be established assuming the mixture stream behaves as a pure system of the most rapidly migrating component with the shortest breakthrough time (i.e., sum up the concentration of the components).
>
> Where the individual compounds in the mixture vary by 2 odors of magnitude or greater, the service life may be based on the contaminant with the shortest breakthrough time.

RESPIRATOR CARTRIDGE CHANGE SCHEDULE

Rule of Thumb *("The Occupational Environment" - Its Evaluation and Control)*

If the chemical's boiling point is >70 C and the concentration is less than 200 pip you can expect a service life of 8 hours at a normal work rate.
Service life is inversely proportional to work rate.
Reducing concentration by a factor of 10 will increase service life by a factor of 5.
Humidity above 85% will reduce service life by 50 %.

OSHA Interpretation

The OSHA inspection procedures for the respiratory protection standard specifies that where contaminant migration is possible, respirator cartridges/canisters should be changed after each work shift where exposure occurs unless there is objective data to the contrary (description studies) showing the performance in the conditions and schedule of use/non-use found in the workplace.

Respiratory Fit Test Record

Attachment 42-5

Name: _____ **Social Security No:** _____

Company/Office: _____ **Last Medical Exam:** _____

Fit Test Date: _____ **Corrective Lenses Needed:** Yes ☐ No ☐

Briefed on fundamental principles of respiratory protection, use, selection, inspection cleaning, maintenance and storage of equipment. Yes ☐ No ☐

Isoamyl acetate odor recognition Yes ☐ No ☐

	RESPIRATOR 1	RESPIRATOR 2	RESPIRATOR 3
Equipment Type			
Manufacturer's Name			
Model			
Size			
Facepiece Composition (Rubber/Silicone)			

TEST PERFORMED	RESPIRATOR 1	RESPIRATOR 2	RESPIRATOR 3
Negative Pressure Test:	P ☐ F ☐	P ☐ F ☐	P ☐ F ☐
Positive Pressure Test:	P ☐ F ☐	P ☐ F ☐	P ☐ F ☐
Isoamyl Acetate Vapor Test:	P ☐ F ☐	P ☐ F ☐	P ☐ F ☐
Irritant Smoke Test:	P ☐ F ☐	P ☐ F ☐	P ☐ F ☐

This qualitative fit test protocol has been adapted from OSHA Respiratory Protection Standard 29 CFR 1910.134, Appendix A.

_____ _____ _____

Examiner's Name (Please Print) **Examiner's Signature** **Date**

_____ _____

Employee's Signature **Date**

URS

URS SAFETY MANAGEMENT STANDARD

Biological Hazards

1. Applicability

This program applies to job activities performed primarily in outdoor environments.

2. Purpose and Scope

The primary goal of this program is to eliminate or reduce illnesses and injuries transmitted by plants, insects, and animals. Although there are many animals and insects that are potentially harmful to humans (i.e. bees, spiders, bears, and rodents), this safety management standard focuses on four common biological hazards: ticks, poison plants, mosquitoes, and snakes.

3. Implementation

The Project Manager, with support from the URS H&S Regional Managers and Occupational Health Specialist, will be responsible for implementation of this program.

4. Requirements

A. Ticks

1. Precautionary Measures

Background information: Ticks do not jump, crawl, or fall onto a person. They are picked up when clothing or hair brushes a leaf or other object the tick is on. Ticks are generally found within three feet of the ground. Once picked up, they will crawl until they find a likely site to feed. Often they will find a spot at the back of the knee, near the hairline, behind the ears, or at pressure points where clothing presses against the skin (underwear elastic, belts, neckline). The best way to prevent tick borne diseases is not to be bitten by a tick. Ticks can carry a number of diseases including:

- Lyme Disease is an infection caused by the corkscrew-shaped bacteria *Borrelia burgdorferi* that is transmitted by the bite of deer tick (ixodes) and western black-legged ticks. The disease occurs in the forested areas of North America, Europe, and Asia. Symptoms which occur 3-30 days following a tick bite include: a spreading 'bulls-eye" rash, fever, fatigue, headache, and joint and muscle aches. Prompt treatment with antibiotics is essential in order to prevent more serious complications that may occur if left untreated.

- Rocky Mountain Spotted Fever is an infection caused by the bacteria *Rickettsia rickettsii*. The disease occurs in North, Central, and South America. Other Rickettsia organisms cause disease worldwide (Mediterranean, Japan, Africa, North Asia). Symptoms which occur 2-6 days following a tick bite include: fever, nausea, vomiting, diarrhea, rash, muscle and joint pain. The disease is treated with antibiotics.

- Babesiosis is caused by hemoprotozoan parasites of the genus *Babesia*. It is transmitted by the ixodid tick. The geographic distribution is worldwide. Symptoms include fever, chills, fatigue, muscle aches, and an enlarged spleen and liver. The disease is treated with anti-protozoan drugs.

- Ehrlichiosis is caused by several bacteria of the genus *Ehrlichiae*. The geographic distribution is global, primarily in temperate regions. Symptoms which occur 5-10 days following a tick bite include fever, headache, fatigue, muscle aches, nausea, vomiting, diarrhea, confusion, and occasionally a rash. The disease is treated with antibiotics.

a. Avoidance of tick habitats

Whenever possible, persons should avoid entering areas that are likely to be infested with ticks, particularly in spring and summer when nymphal ticks feed. Ticks favor a moist, shaded environment, especially that provided by leaf litter and low-lying vegetation in wooded, brushy, or overgrown grassy habitat. Both deer and rodent hosts must be abundant to maintain the life cycle of the tick.

b. Personal Protective Equipment

1. Wear light colored clothing or white Tyvek® to allow you to see ticks that are crawling on your clothing.

2. Tuck your pant legs into your socks or boots, wear high rubber boots, or use tape to close the opening where they meet so that ticks cannot crawl up the inside of your pant legs.

3. Wear a hat, tie back long hair.

4. Apply repellents to discourage tick attachment. Repellents containing permethrin can be sprayed on boots and clothing and will last for several days. Repellents containing DEET (n,n-diethyl-

m-toluamide) can be applied to the skin, but will last only a few hours before reapplication is necessary. Apply according to Environmental Protection Agency guidelines to reduce the possibility of toxicity.

c. Tick Check

1. Change clothes when you return from an area where ticks may be located.

2. Shower to wash off any loose ticks.

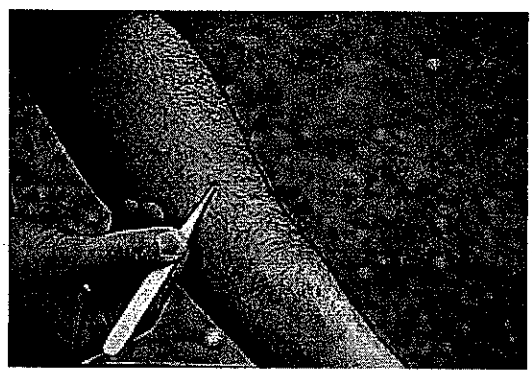
3. Check your entire body for ticks. Use a hand held or full-length mirror to view all parts of your body.

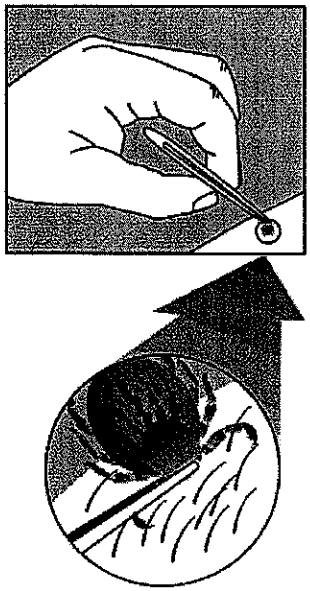
4. Place clothing worn in tick infested areas into the dryer for at least 30 minutes in order to kill any ticks.

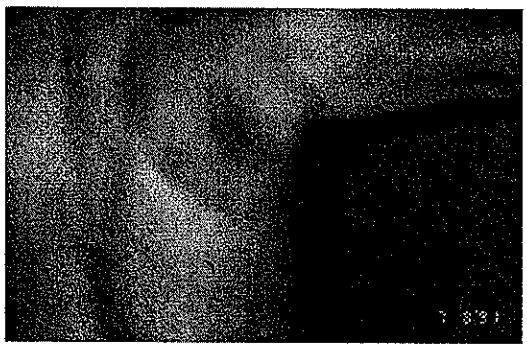
2. Tick Removal

Because it takes several hours of attachment before microorganisms are transmitted from the tick to the host, prompt removal of attached or crawling ticks is an important method of preventing disease. Remember, folklore remedies of tick removal to do not work! Methods such as the use of petroleum jelly or hot matches may actually make matters worse by irritating the tick and stimulating it to release additional saliva or regurgitate gut contents, increasing the chances of transmitting disease.

The best method to remove an attached tick is with a set of fine tipped tweezers.







a. Use fine-tipped tweezers. When possible, avoid removing ticks with bare hands.

b. Grasp the tick as close to the skin surface as possible and pull upward with steady, even pressure. Do not twist or jerk the tick; this may cause the mouthparts to break off and remain in the skin. If this happens, remove mouthparts with the tweezers.

c. Do not squeeze, crush, or puncture the body of the tick because its fluids (saliva and gut contents) may contain infectious organisms.

d. After removing the tick, thoroughly disinfect the bite site and wash your hands with soap and water.

e. Disinfect the tweezers.

f. Save the tick for identification in case you become ill. This may help the doctor make an accurate diagnosis. Place the tick in a vial or plastic zip lock bag and put it in the freezer. Write the date of the bite on a piece of paper with a pencil and place it in the bag.

3. Medical Follow-Up

In most circumstances, medical treatment of persons who only have a tick bite is not recommended. However, individuals who are bitten by a tick

should seek medical attention if any signs and symptoms of tick borne disease develop over the weeks following the tick bite.

B. Poisonous Plants

1. Background Information

Poison ivy and poison oak plants are the most common cause of allergic contact dermatitis in North America. These poisonous plants can be a hazard for many various outdoor activities at work, home, and play. Skin contact with the oleoresins (urushiol) from these plants can cause an itchy, red, oozing, blistered rash in sensitive individuals. Oil content in the plants is highest in the spring and summer, however the plants are even hazardous in the winter when they have dropped their leaves. There are three types of exposure:

- Direct contact: An initial skin exposure in necessary to "sensitize" the individual. Subsequent contact in a sensitized person will result in a rash appearing within 4 to 48 hours. Approximately 50-70 % of the population is sensitized. Poison plant dermatitis is usually characterized by areas of linear or streaked patches where branches of the plant brushed the skin.

- Indirect contact: Skin exposure can happen indirectly. Clothing, shoes, tools, personal protective equipment and other items can be contaminated with the oils and maintain potency for months.

- Airborne smoke contact: Never burn poison plants. Droplets of oil can be carried by smoke and enter the respiratory system causing a severe internal outbreak.

Poison plant rash is not contagious. Skin contact with blister fluid from an affected individual will not cause dermatitis in another sensitized person. Scratching the rash can only spread it to other parts of your body if the oil is still on your skin. After the oil has been washed off or absorbed by the skin, scratching will not spread the rash.

The most distinctive features of poison ivy and poison oak are their leaves, which are composed of three leaflets each and are green in the summer and red in the fall. Both plants also have greenish-white flowers and berries that grow in clusters. All parts of these plants are toxic.

Poison Ivy grows as a small plant, vine, and as a shrub. Leaves always consist of three glossy leaflets.

Poison Ivy

Poison Oak grows as a shrub or vine. It has three leaflets that resemble oak leaves.

Eastern Poison Oak

Poison Sumac grows as a woody shrub or small tree from 5 to 25 feet tall. It has 7 to 13 leaves that grow opposite each other with a leaflet at the tip.

Poison Sumac

1. Precautionary Measures

   - The best approach is to learn to identify the plants and avoid them.
   - Wear long pants and long sleeves, boots and gloves.
   - Barrier skin creams may offer some protection if applied before contact.

- Avoid indirect contact from tools, clothing or other objects that have come into contact with a crushed or broken plant. Don't forget to wash contaminated clothing and clean up contaminated equipment.

- If you can wash exposed skin areas within 3-5 minutes with cold running water, you may keep the urushiol from penetrating your skin. Proper washing may not be practical in remote areas, but a small wash-up kit with pre-packaged alcohol-based cleansing tissues can be effective.

2. Medical Follow-Up

   Home treatment: Calamine lotion and an oatmeal (one cup to a tub full of water) bath can help relieve itching. To prevent secondary skin infection, scratching is not helpful and the finger nails should be cut to avoid damage to the skin. Over-the-counter hydrocortisone cream can decrease inflammation and itching, however read the label and use according to directions.

   When to see the doctor: Severe cases may require further treatment. A physician should be seen if the rash appears infected, is on the face or other sensitive body areas, or is too extensive to be easily treated at home.

C. Mosquito Borne Diseases

1. Background Information

   a. Arboviral encephalitis is a viral illness causing inflammation of the brain and is transmitted to humans by the bite of infected mosquitoes. Globally there are several strains including: Eastern equine, Japanese, La Crosse, St. Louis, West Nile, and Western equine encephalitis. Some of the strains have a vaccine. Symptoms of infection are nonspecific and flu-like: fever, headache, and tiredness. Fortunately, only a small proportion of infected people progress to encephalitis. Treatment is supportive, antibiotics are not effective.

   b. Malaria is a serious but preventable disease spread by the bite of an infected anopheline mosquito. It is caused by four species of the parasite *Plasmodium (P. falciparum, P. vivax, P. ovale, and P malariae)*. Malaria-risk areas include primarily tropical areas of Central and South America, Africa, India, Southeast Asia, and the Middle East. Symptoms of malaria which occur 8 days to 1 year after infection

include fever, shaking chills, headache, muscle ache, tiredness, jaundice, nausea, vomiting, and diarrhea. Malaria can be cured with prescription drugs.

c. Dengue Fever is a potentially life-threatening viral illness transmitted by the bite of the Aedes mosquito, found primarily in urban areas. The disease is found in most of tropical Asia, the Pacific Islands, Central and South America, and Africa. There are four dengue virus serotypes. Symptoms include sudden onset, high fever, severe headache, joint and muscle pain, rash, nausea and vomiting. There is no specific treatment and no vaccine.

d. Yellow Fever is a viral disease transmitted between humans by mosquitoes. It occurs only in Africa and South America. There is a vaccine that confers immunity lasting 10 years or more. Symptoms begin 3-6 days after the mosquito bite and include fever, nausea, vomiting, headache, slow pulse, muscle aches, and restlessness. Treatment is symptomatic.

2. Precautionary Measures

- Insect Repellent – Use insect repellants that contain DEET. The effect should last about 4 hours. Always use according to label directions. Use only when outdoors and wash skin after coming indoors. Do not breathe in, swallow, or get into the eyes. Do not put on wounds or broken skin.

- Protective Clothing – wear long sleeved shirts and long pants, especially from dusk to dawn. Or avoid going outdoors during these hours.

- Mosquito netting – Travelers who will not be staying in well-screened or air conditioned rooms should use a pyrethroid containing flying insect spray in living and sleeping areas during evening and nighttime hours. Sleep under mosquito netting (bed nets) that have been sprayed with permethrin.

- Malaria prophylaxis medications may be prescribed, however they do not provide complete protection. The type of medication given depends on the area of travel.

D. Poisonous Snakes

1. Background Information

No single characteristic distinguishes a poisonous snake from a harmless one except the presence of poison fangs and glands. Only in dead specimens can you determine the presence of these fangs and glands without danger. Most poisonous snakes have both neurotoxic and hemotoxic venom, however, one type is dominant and the other is weak.

a. Hemotoxic venom. The folded-fang snakes (fangs can raise to an erect position) have venoms that affect the circulatory system, destroying blood cells, damaging skin tissues, and causing internal hemorrhaging.

b. Neurotoxic venom. The fixed-fang snakes (permanently erect fangs) have venoms that affect the nervous system, making the victim unable to breathe.

c. Poisonous snakes in the Americas: copperhead, coral snake, cottonmouth, and rattlesnake.

d. Poisonous snakes in Europe: adder, viper.

e. Poisonous snakes of Africa and Asia: viper, cobra, adder, green mamba.

f. Poisonous snakes in Australia: copperhead, adder, taipan, tiger snake.

2. Precautionary Measures

Bites occur when you don't hear or see the snake, when you step on them, or when you walk too close to them. Follow these simple rules to reduce the chance of accidental snakebite:

- Don't put your hands into dark places, such as rock crevices, heavy brush, or hollow logs, without first investigating.
- Don't step over a fallen tree. Step on the log and look to see if there is a snake resting on the other side.
- Don't walk through heavy brush or tall grass without looking down. Look where you are walking.

- Do not pick up any live snake. If you encounter a snake, walk around the snake, giving it plenty of room. A snake can strike half its length.
- Don't pick up freshly killed snakes without first severing the head. The nervous system may still be active and a dead snake can deliver a bite.

3. Medical Follow-up

If you are bitten by a snake, the primary goal is to get to a hospital as soon as possible to receive professional medical evaluation and possible treatment with antivenom if warranted. Initial first aid should include: Wash the bite with soap and water. Immobilize the bitten area and keep it lower than the heart. Try to remain calm. If you are unable to reach a hospital within 30 minutes, a bandage, wrapped two to four inches above the bite, may help slow the venom. The bandage should not cut off blood flow from a vein or artery, make sure the band is loose enough that a finger can slip under it. A suction device from a commercial snakebite kit may be placed over the bite to help draw venom out of the wound.

Research has shown the following to be potentially harmful, DO NOT: apply ice, use a tourniquet, or make incisions into the wound.

5. Documentation Summary

Complete and distribute a URS Incident Report form 49-1 for all work-related biological exposure incidents.

6. Resources

Centers for Disease Control
http://www.cdc.gov

U. S. Occupational Safety and Health Administration
http://www.osha.gov

U.S. Food and Drug Administration
Treating and Preventing Venomous Snake Bites

URS SAFETY MANAGEMENT STANDARD
Injury / Illness / Incident Reporting & Notifications

1. Applicability

This procedure applies to URS Corporation offices and field operations.

2. Purpose and Scope

The purpose of this procedure is to provide guidance for the timely reporting of work related injuries, illness, and incidents. This procedure also defines incident notification procedures for URS employees. Note – For incidents involving motor vehicles, the reporting and notification requirements of URS SMS 057 – Vehicle Safety Program may also apply.

For significant incidents (e.g., fatality, serious injury, injury to members of the public), SMS 066 – Incident Investigation is also required.

3. Implementation

Office Locations - Implementation of this program is the responsibility of the employee's Supervisor.

Field Activities - Implementation of this program is the responsibility of the Project Manager.

4. Requirements

A. Reporting: All employees shall immediately notify their appropriate level of management (line, project, and/or office) of a reportable incident. A reportable incident includes the following:

1. An injury or illness to any URS employee or subcontractor, even if the injury does not require medical attention;
2. An injury to a member of the public, including clients, occurring on a URS controlled work site;
3. Illness resulting from suspected chemical exposure;
4. Chronic or re-occurring conditions such as back pain or cumulative trauma disorders (example: carpal tunnel syndrome);
5. Fire, explosion, or flash;
6. Any vehicle accidents occurring on site, while traveling to or from client locations, or with any company-owned, rented, or leased vehicle (including personal vehicles used for company business);

7. Property damage resulting from any URS or subcontractor activity;
8. Structural collapse or potential structural hazards;
9. Unexpected release or imminent release of a hazardous material;
10. Unexpected chemical exposures to workers or the public;
11. A safety related complaint from the public regarding URS activities.
12. Incidents that could result in adverse public media interest concerning URS or a URS project.
13. Any incident that could result in, or any actual investigation by, OSHA, DOT, EPA, or State, Federal, or local law enforcement agency.
14. Any other significant occurrence that could impact safety – including a near-miss.

Note: A near-miss is defined as an incident having the potential to cause significant injury or property damage as listed above – but did not. Examples of a near-miss include:

A worker steps off a ledge and falls three feet (1 meter) to the floor – and is uninjured.

A crane drops a 1,000-pound (454 kg) beam during a lift – and nobody is hurt, no equipment is damaged.

A work crew is conducting a survey along the highway. A vehicle leaves the roadway (driver asleep) and the vehicle enters the survey area at 50 mph (80 kph). The vehicle misses an employee by 3-feet (1 meter), the driver recovers control of the vehicle and leaves the area.

B. Actions: The following actions will be taken following a reportable incident:

1. Employees:

   a. If necessary, suspend operations and secure and/or evacuate the area;

   b. Immediately notify your supervisor and/or project manager

   c. Record information pertaining to the incident (e.g., time, date, location, name and company of person(s) involved witnesses,

description of event, and actions taken) and initiate either an Incident Report (49-1) or Near-Miss Report (49-2);

d. Assist with incident investigation as directed by management;

e. Implement corrective actions as directed by management;

f. *Do not* discuss the incident with members of the news media or legal representatives (except URS legal counsel or your personal legal advisor) unless directed to do so by URS management;

g. *Do not* make statements pertaining to guilt, fault, or liability.

2. Line/Project Management:

a. For instances involving serious accidents, injuries, or other significant consequences, verbally notify the URS H&S Management Team as soon as possible at the following numbers:

In the U.S., Canada, and Mexico: (866) 326-7321
Fax +1 (512) 419 6413

In Europe: +44-1291-621768
Fax +44 1291 621768

In Asia/Pacific: +61 (3) 8699 7500
Fax +61 (3) 8699 7550

Notification should in no case occur later than the end of the work shift. Follow-up notification by faxing an SMS 49-1 Incident Report Form within 24 hours to the URS Occupational Health Manager (OHM) at +1-512.419.6413. Also, assure copies of the report are distributed as outlined on the form.

URS Corporate H&S Management will make notification to Federal and State authorities as appropriate.

b. For minor incidents involving only first aid treatment, minor damage to vehicle of equipment, etc., make notifications to the above number as soon as reasonable during normal business hours and fax the SMS 49-1 Incident Report Form to the URS

OHM within 24 hours at +1-512.419.6413. Also, assure copies of the report are distributed as outlined on the form.

c. For a near-miss incident, complete the Near-Miss Report Form (49-2) and give it to the Office or Project Health and Safety Representative. Also, assure copies of the report are distributed as outlined on the form.

d. Review circumstances (i.e., who, what, when, where, and how) of the incident with applicable employee(s) to determine apparent causes and to develop recommended corrective actions;

e. Discuss with department or project staff the circumstances surrounding the incident and corrective actions taken.

3. Local Office or Project Health And Safety Representative

   a. Assist with incident evaluation;

   b. With management, identify cause(s) of incident and identify corrective actions needed to avoid recurrence;

   c. Review injury/incident report or the near-miss report for completeness and accuracy. Assure the reports are distributed properly.

   d. Assure notifications are made in a timely manner.

   e. Assure that the injured employee is properly counseled/advised as directed by SMS 65 - Injury Management. Communicate with the OHM at (866) 326-7321.

4. Occupational Health Manager

   a. Report work-related injuries and illness to workers' compensation carrier.

   b. Assure that the employee's injury is managed in accordance with SMS 065. Provide guidance for the affected Office or Project Health and Safety Representative.

   c. Periodically disseminate near-miss reporting summary information to the Regional and Corporate H&S Managers.

5. Corporate Health and Safety Management

   a. Notify URS management of any significant occurrence including lost-time injuries, deaths, or other serious result or circumstance.

   b. The Occupational Health Manager (OHM) will review all reported incidents to determine OSHA reporting and recording requirements with input from the appropriate Corporate Health and Safety Manager. For a determination of recordability in those infrequent instances where there is not a clear answer, the Vice President, Health, Safety, and Environment shall make the final determination. All decisions will be based strictly on current Federal OSHA guidelines.

   c. Official records (including required reports and logs for all reported incidents) will be maintained at one central location by the OHM.

   d. Each January the OHM will prepare and distribute, to each URS establishment, the appropriate government injury/illness reports. These reports will summarize all required government information for incidents that occurred during the preceding calendar year.

5. Documentation Summary

A. File these records in the Office Safety File:

   1. Attachment 49-1 - Incident Report Form

   2. Attachment 49-2 – Near-Miss report

B. File these records in the Project Health and Safety File

   1. Attachment 49-1 - Incident Report Form

   2. Attachment 49-2 – Near-Miss report

URS	Health and Safety Program **INCIDENT REPORT FORM**	Attachment 49-1 Revision 2: May 2004

ADMINISTRATIVE INFORMATION:

URS Division/Company: _____

Project or Office: _____

Project Number: _____

Date/Time of Incident: _____ _____

Location/Client Name: _____ _____

TYPE OF INCIDENT (Check all applicable items)			
☐ Illness	☐ Injury	☐ Fire, Explosion, Flash	☐ Unexpected Exposure
☐ Property Damage	☐ Vehicular Accident	☐ Other (describe):	

FOR INJURIES/ILLNESS ONLY	
Name of Injured Employee _____	Phone No. _____
Describe Injury _____	
Medical Treatment / First Aid _____	

EMPLOYEES' DESCRIPTION OF INCIDENT: (Describe the facts contributing to the incident. Identify individuals involved, witnesses, and their affiliations. Attach additional sheets, drawings, or photographs as needed.)

_____

_____

_____

_____

_____

_____

_____

_____

Employee Name _____

Employee Signature _____ Date _____

URS	Health and Safety Program **NEAR-MISS REPORT**	Attachment 49-2 Issue Date: Feb. 2003

URS Division/Company: _____

Project /Location _____

Date/Time of Near-miss: _____

Name of Preparer: _____ Date: _____

The following is an account of what happened:

I believe this could have resulted in injury and/or damage to: (Check all that pertain)

❑ **Personnel** ❑ **Property** ❑ **Equipment**

If these circumstances occurred:

I recommend the following actions to prevent this from occurring in the future:

REVIEWED BY:

Project Manager _____ Date _____

Health and Safety Representative _____ Date _____

DISTRIBUTION:

- **Regional H&S Manager**
- **Project / Office file**
- **URS Occupational Health Manager**
  Fax: 512.419.6413
  Phone: 866.326.7321

ERROR: invalidrestore
OFFENDING COMMAND: restore

STACK:

-savelevel-

URS SAFETY MANAGEMENT STANDARD
Bloodborne Pathogens

1. Applicability

This program applies to all employees who may incur exposure to blood or other potentially infectious body fluids as a result of performing their assigned job duties. Examples include: designated first aid responders or work assignment at a client's medical laboratory site. Note: Sewage work does not typically involve exposure to bloodborne pathogens even though other biological hazards may be present.

2. Purpose and Scope

The purpose of this program is to identify jobs and tasks where occupational exposure to bloodborne pathogens (i.e. Human Immunodeficiency Virus, Hepatitis B and C Viruses, and others) may occur and to implement controls which will eliminate or significantly reduce the risk of infectious bloodborne diseases in accordance with the OSHA Bloodborne Pathogen Standard (29 CFR 1910.1030). This program also includes provisions for affected employees to receive personal protective equipment, Hepatitis B vaccinations, training, and if necessary, confidential medical evaluations and follow up.

3. Implementation

Office/Laboratory Locations – Implementation is the responsibility of the Operations Manager.

Field Activities – Implementation is the responsibility of the Project Manager.

Program Administration – The Occupational Health Specialist (OHS) and URS Health & Safety Director are responsible for implementation and annual evaluation of the Exposure Control Plan (ECP) – Attachment 51-1. The OHS will ensure that all medical actions required are performed and that the appropriate employee health and OSHA records are maintained. The URS Health & Safety Director will oversee provisions of necessary personal protective equipment and supplies, training, documentation of training, and will make the written ECP available to employees and OSHA representatives.

4. Requirements

A. Risk Identification

1. The Project Manager, with assistance from the site Health & Safety Representative, will perform an exposure determination concerning

which employee may or may not have exposure to bloodborne pathogens. Employees will be classified into two categories:

a. Employees formally designated as part of their job to perform tasks that may involve direct contact with blood or potentially infectious body fluids.

   i. Requires initial and annual training

   ii. Hepatitis B vaccination series will be offered

   iii. Requires procedures be followed in ECP

b. Employees not assigned to jobs or tasks that involve exposure to blood or potentially infectious body fluids, but who could in extraordinary situations, voluntarily assist injured or ill individuals, and therefore could have exposure to bloodborne pathogens.

   i. Requires post-exposure procedures outlined in ECP

2. The ECP will be reviewed and updated at least annually, and whenever necessary to include new or modified tasks and procedures.

B. Exposure Control Methods

1. All employees will utilize universal precautions – an approach to infection control where all human blood and body fluids are treated as potentially infectious.

2. Engineering and work practice controls (e.g. sharps disposal containers, perform procedures to prevent splashing) will be used to eliminate or minimize exposure to employees.

3. Personal protective equipment (e.g. disposable gloves, face masks with eye protection, liquid impermeable gowns, CPR pocket masks) will be provided and used in order to place a barrier between the employee and the blood or body fluids.

4. Hands are to be washed immediately with soap and water after removing gloves or performing any work with blood or body fluids.

5. Housekeeping and decontamination of work surfaces with EPA-registered germicides or a bleach solution diluted 1:10 with water, will be performed as needed to maintain a safe working environment.

6. Regulated biohazardous waste (contaminated sharps or items that are capable of releasing blood or body fluids through employee handling) will be disposed of in special waste receptacles lined with red bags and incinerated per federal and state regulations. This does not include small amounts of waste from a minor wound which can be sealed in a plastic bag and disposed of in regular trash.

C. Hepatitis B Vaccination series will be made available to all employees who have been designated to perform tasks that involve direct exposure to bloodborne pathogens. Further, this vaccination series will be made immediately available to employees that have had an occupational bloodborne exposure incident, whether as a result of their assigned tasks or occurring as a result of incidental contact.

D. In the event that an employee is exposed to blood or body fluids, they should immediately flush the affected area with copious amounts of water. A confidential medical evaluation and follow-up with an occupational physician should be arranged for the employee as soon as possible following the report of an exposure incident, preferably within 1-2 hours after the exposure incident has occurred.

E. Hazard Communication

1. Orange-red biohazard warning labels will be used to identify lab areas or disposal containers with blood or other potentially infectious materials present.

2. Initial and annual training classes will be conducted by the Division Health & Safety Managers for all employees assigned to tasks where occupational exposure may occur.

F. Exposure Incident Investigation

The OHS and Division Health & Safety Manager will review the circumstances of each exposure incident to determine if the appropriate work procedures were being followed at the time of the incident and to assess and implement any necessary corrective actions, including changes required in the ECP.

5. Documentation Summary

A. Distribute Medical Surveillance Evaluation form to Medical Services Provider, site Health & Safety Representative, and Supervisor.

B. Post-exposure medical records from consulting physician and exposure incident reports will be retained in employee's confidential medical record.

C. Send initial and annual training records to the Division Health & Safety Manager.

D. Regulated infectious medical waste manifest records will be stored by the site Health & Safety Representative.

6. Resources

A. U.S. OSHA 29 CFR 1910.1030 Occupational Exposure to Bloodborne Pathogens Standard, current revision.

B. Centers for Disease Control Morbidity and Mortality Weekly Report: "Public Health Service Guidelines for the Management of Health-Care Worker Exposure to HIV and Recommendations for Post-exposure Prophylaxis" May 15, 1998; Vol. 47, No. RR-7.

C. Centers for Disease Control Morbidity and Mortality Weekly Report: "Immunization of Health-Care Workers: Recommendations" December 26, 1997; Vol. 46, No. RR-18.

D. Centers for Disease Control Morbidity and Mortality Weekly Report: "Recommendations for Prevention and Control of Hepatitis C Virus (HCV) Infection and HCV-Related Chronic Disease" October 16, 1998; Vol. 47, No. RR-19.

E. Bloodborne pathogens standard and the construction industry (OSHA letter of interpretation 01-26-93)

F. Clarification on first aid requirements for hazardous waste sites (OSHA letter of interpretation 04-20-93)

G. Worksafe Australia: National Occupational Health & Safety Commission. National Code of Practice for health care workers and other people at risk of the transmission of Human Immunodeficiency Virus and Hepatitis B in the workplace. [NOHSC: 2010(1993)]

BLOODBORNE PATHOGENS EXPOSURE CONTROL PLAN

1. Introduction

Employees are at risk for exposure to and possible transmission of infectious diseases each time they are in contact with blood or body fluids. Bloodborne pathogens are microorganisms present in human blood and other body fluids that can cause serious disease in humans and include, but are not limited to Hepatitis B Virus (HBV), Hepatitis C Virus (HCV), and Human Immunodeficiency Virus (HIV). Therefore, this exposure control plan (ECP) has been established to ensure that employees are effectively informed concerning potential workplace health hazards and that protective measures necessary to eliminate or minimize bloodborne exposure incidents are utilized whenever possible.

2. Exposure Determination

The Medical Surveillance Evaluation form will be used to evaluate which employees may incur occupational exposure to blood or other potentially infectious materials when performing routine tasks and procedures. These exposure determinations will be made without regard to the use of personal protective equipment and regardless of exposure frequency.

The employees in the following job classifications may have occupational exposure to bloodborne pathogens and are covered by this program:

Occupational health nurse

Designated first aid providers

Medical laboratory employees

Tasks and procedures which may expose employees to bloodborne pathogens include:

Treating cuts, abrasions, and burns

Cleaning contaminated environmental surfaces

Administering cardiopulmonary resuscitation (CPR)

Collecting samples at municipal waste sites or sewage lagoons

Environmental sewer samplers or sewer construction workers

Construction of residential sewer lines

3. Exposure Control

A. "Universal precautions" are a required method of control to prevent exposure to blood and body fluids. This term refers to the concept that all human blood and certain human body fluids are treated as if known to be infectious for HIV,

HBV, HCV, and other bloodborne pathogens, regardless of the perceived risk status of another individual. Universal precautions apply to blood, other body fluids containing visible blood, semen, and vaginal fluids. Universal precautions do not apply to feces, nasal secretions, saliva, sweat, tears, sputum, urine, and vomitus unless they contain visible blood. Although these fluids have an extremely low or nonexistent risk for bloodborne pathogens, they are a potential source for other infectious diseases and precautions should also be followed when these body fluids are present.

B. Engineering and Work Practice Controls

The following engineering controls shall be in place in all areas of occupational exposure:

1. Accessible handwashing facilities. If soap and running water are not available, an antiseptic hand cleaner in conjunction with clean paper towels or antiseptic towelettes are acceptable temporary alternatives to running water. When this alternative method is used, employees must wash their hands with soap and running water as soon as feasible.
2. Containers for disposable contaminated sharps will be puncture resistance, labeled a biohazard, leakproof, and have a closable top.
3. Containers for storage, transport, or shipment of blood or other potentially infectious materials, regulated waste, and contaminated laundry will be labeled with the biohazard symbol, site address, and have a securely closing lid.

The following work practice controls must be strictly followed to minimize exposure and isolate or remove bloodborne pathogens from the workplace:

4. Personal protective equipment will be provided at no cost to the employee will be chosen based on the anticipated exposure to blood. PPE is considered appropriate if it does not permit blood or other potentially infectious materials to reach or pass through clothes, skin, or mucous membranes of the eyes or mouth under normal conditions of use and for the duration of time the equipment will be used. PPE must be readily accessible and will be removed prior to leaving the work area.
    a. Disposable, single use gloves shall be used as a protective barrier in all situations in which contact with body fluids is anticipated. Gloves of the correct size will be provided. Disposable gloves will not be washed or disinfected for reuse and will be replaced between employees and if they become torn or punctured. Gloves are especially important if the employee has cuts, abraded skin, chapped hands, or dermatitis.

b. Liquid impermeable gowns, boots, and masks, in combination with eye protective devices such as goggles and shatterproof glasses with solid-side shields or chin-length face shields, shall be worn whenever splashing, spraying, or spattering of blood droplets or body fluids can be reasonably anticipated.

c. Disposable pocket mask ventilation devices should be provided in all first aid kits and used to avoid mouth-to-mouth contact during emergency cardiopulmonary resuscitation.

Examples of Recommended PPE (depending on task, more PPE may be needed).

Task	Gloves	Gown	Mask	Goggles	Boots
Bleeding control w/ minimal bleeding	Yes	No	No	No	No
Bleeding control w /spurting blood	Yes	Yes	Yes	Yes	No
Cardiopulmonary resuscitation	No	No	Yes	No	No
Decontamination/clean-up	Yes	No	No	No	No
Collection of sewage waste	Yes	No	No	Yes	Yes
Construction of sewage lines	Yes	No	No	Yes	Yes
Medical laboratory activities	Yes	Yes	Yes	Yes	No

5. Eating, drinking, smoking, applying cosmetics, and handling of contact lenses are prohibited in work areas where there is a reasonable likelihood of occupational exposure. Food and drink will not be kept in refrigerators, freezers, shelves, cabinets, or on counter tops where blood or body fluids are present.
6. Contaminated needles and other sharps will not be bent or recapped unless a one-handed technique is used. They will be disposed of in an appropriate sharps container.
7. All regulated, biohazardous waste will be placed in a waste receptacle that has designated red biohazard bags and a closable top controlled by a foot peddle. When full, the bags shall be removed with gloved hands, tied off, and placed in a biohazard shipping carton, to be held for pick-up. If any biohazard bag appears to be leaking, it must be double-bagged. The waste will be incinerated per federal and state regulations.

C. Housekeeping

1. Universal precautions will be used when cleaning or decontaminating any surface or equipment that may be contaminated. Appropriate PPE will be used for protection during decontamination.
2. All contaminated environmental work surfaces such as countertops or floors will be cleaned with a household bleach solution diluted 1:10 with water directly following contamination with blood or body fluids.
3. Instruments such as tweezers, bandage scissors, and thermometers will be disposable rather than reusable equipment and will be disposed of in an appropriate manner.
4. Broken, contaminated glassware will not be picked up directly with the hands. It will be cleaned up using a mechanical means such as a brush and dustpan or tongs.

4. Hepatitis B Vaccination

Within 10 working days of placement, all employees assigned to tasks with potential occupational exposure to bloodborne pathogens will be offered the Hepatitis B vaccination at no cost to the employee, unless the employee has had a previous Hepatitis B vaccination series, antibody testing reveals the employee is immune or the vaccine is contraindicated for medical reasons. Further, this vaccination series will be made immediately available to employees who have an occupational exposure whether as a result of their assigned tasks or occurring from an incidental contact.

The local occupational medical facility used for routine medical surveillance will administer the vaccinations.

Employees who decline the Hepatitis B vaccine will sign a copy of the waiver form located at the end of this attachment. The signed waiver will be stored in the employee's medical record with the Occupational Health Specialist. Employees may initially decline the vaccination, but at a later date, while still covered under this plan, may then decide to take them. The vaccinations will be made available to the employee at that time.

Employees choosing to take the vaccination series will sign a consent form at the occupational clinic prior to receiving the injections and are advised to read the package insert regarding the efficacy, safety, method of administration, and benefits of the vaccine. Employees may also ask questions directly of the Medical Service Provider or local occupational physician. Employees are not required to participate in a prescreening program (to determine immunity) before receiving the vaccinations. If a routine booster of Hepatitis B vaccine is recommended by the U.S. Public Health Service at a future date, such booster dose(s) will be made available to affected employees.

5. Post-Exposure Incident Evaluation And Follow-Up

All occupational bloodborne pathogen exposures are to be reported to a Health & Safety Representative or the Occupational Health Specialist immediately after initial decontamination first aid is accomplished. Following the report of an exposure incident, a confidential medical evaluation with an occupational physician will be arranged as soon as possible, ideally no later than 1-2 hours after the incident has occurred. In some states, depending on applicable workers' compensation law, employees may choose treatment from their personal physician. A copy of the Bloodborne Pathogen Standard will be provided if the physician does not have a copy. A written URS Incident Report will be completed as soon as possible, fully describing the incident.

A. First aid protocol for treatment immediately after an exposure incident:

1. Lacerations, punctures, and abrasions should be washed under cool running water for at least 5 minutes allowing free bleeding. Cleanse area well with soap or iodine solution. Apply sterile dressing as needed. Give tetanus booster if indicated (7-10 years since last booster).
2. Ocular exposure requires irrigation of the eye with water or sterile normal saline solution for 15 minutes.
3. Mucous membrane exposure requires rinsing mouth with ½ strength 3% hydrogen peroxide for 30 seconds, four separate and consecutive times.

B. Confidential Medical Evaluation

1. The treating occupational physician will receive documentation of the routes of exposure, the circumstances surrounding the incident, and identification of the source individual (the individual the employee was exposed to). The blood of the source individual will be tested if possible and after consent is obtained. When legally permissible, results of testing of the source individual will be made available to the exposed employee with the exposed employee informed about the applicable laws and regulations concerning the disclosure of the identity and infectivity of the source individual.
2. Testing of the exposed employee's blood, if consented to (the employee may consent to baseline blood collection, but may request that the sample not be tested for HIV for up to 90 days, it at all), is recommended.

3. Post-exposure medical treatment will be offered in accordance with the current recommendations of the U.S. Public Health Services. This may include, but is not limited to:
   a. A series of HIV post-exposure blood tests
   b. Hepatitis B vaccination and/or Hepatitis B immune globulin
   c. HIV post-exposure prophylactic medications
   d. Evaluation of acute febrile illnesses following exposure
   e. Employee counseling concerning precautions to take during the period after the exposure incident and information on signs and symptoms of potential illnesses.

C. Healthcare Professional's Written Opinion

The Occupational Health Specialist will obtain and provide the employee with a copy of the evaluating physician's written opinion within 15 days of the completion of the medical evaluation. A copy will be maintained in the employee's confidential medical record. The written opinion will be in accordance with the requirements of the Bloodborne Pathogens Standard indicating that the employee has been informed of any medical conditions resulting from exposure that require further evaluation or treatment. All other findings or diagnoses will remain confidential and will not be included in the report.

6. Hazard Communication

A. Fluorescent red or orange-red warning labels bearing the universal biohazard symbol and the legend BIOHAZARD must be firmly affixed to all containers (e.g. waste cans, sharps containers, and refrigerators) used for the storage or shipment of blood or other potentially infectious materials.

B. All employees designated to perform tasks involving occupational exposure shall receive bloodborne pathogens training at the time of initial assignment to the job. This training will be given during working hours and at no cost to employees. Refresher courses will be provided annually and if new tasks or procedures are implemented. Material appropriate in content and vocabulary to education level, literacy, and language of the employees shall be used for all required training. The Division Health & Safety Representatives will be the qualified instructors for the training classes.

Training will include: making accessible a copy of the regulatory text of the standard and explanation of its contents, general discussion on bloodborne diseases and their transmission, exposure control plan, engineering and work practice controls, personal protective equipment, hepatitis B vaccine,

response to emergencies involving blood, how to handle exposure incidents, the post-exposure evaluation and follow-up program, signs/labels/color-coding, and question and answer time with the trainer.

7. Exposure Incident Investigation

The site Health & Safety Representative will review the circumstances of any exposure incident to determine corrective actions. The incident report will include:

A. Engineering controls in use at the time

B. Work practices followed

C. A description of any equipment being used

D. A description of the work being performed

E. PPE that was used at the time of the incident

F. Date, time, and location of the incident

G. Employee's training

Within 24 hours, a copy of this incident report will be forwarded to the Occupational Health Specialist and Division Health & Safety Manager who will evaluate what follow-up actions should be addressed, including if revisions need to be made to the Exposure Control Plan.

8. Recordkeeping

A. The Occupational Health Specialist will be responsible for establishing and maintaining accurate, confidential workers' compensation medical records for each employee with occupational exposure for the duration of employment plus 30 years in accordance with OSHA 29 CFR 1910.1020 "Access to Employee Exposure and Medical Records".

B. The Division Health & Safety Manager will responsible for maintaining the bloodborne pathogens training class records for at least 3 years from the date of training. The records will include the date of the training class, a summary of the class contents, the names of the qualified instructors, and the names and job titles of person attending the training.

C. Employee medical records will be made available to employees (or their designated representative) with written consent by the employee within 15 working days of request.

D. An exposure incident will be evaluated by the Occupational Health Specialist and Corporate Health & Safety Managers to determine if the case meets OSHA's Recordkeeping Requirements (29 CFR 1904).

HEPATITIS B VACCINATION DECLINATION FORM

I understand that due to my occupational exposure to blood or other potentially infectious materials I may be at risk of acquiring hepatitis B virus (HBV) infection. I have been given the opportunity to be vaccinated with hepatitis B vaccine, at no charge to myself. However, I decline hepatitis B vaccination at this time. I understand that by declining this vaccine, I continue to be at risk of acquiring hepatitis B, a serious disease. If in the future I continue to have occupational exposure to blood or other potentially infectious materials and I want to be vaccinated with hepatitis B vaccine, I can receive the vaccine series at no cost to me.

Name _____

Date _____

Witness _____

Date _____

URS SAFETY MANAGEMENT STANDARD
Drilling Safety Guidelines

1. Applicability

This program applies to URS projects in which truck-mounted, or other engine powered, drill rigs are used. For drill rigs operated by contractors, the primary responsibility for drilling safety is with the drilling contractor.

2. Purpose and Scope

The purpose of these guidelines is to provide an overview for working safely around drilling operations with truck-mounted and other engine-powered drill rigs. The procedure addresses off-road movement of drill rigs, overhead and buried utilities, use of augers, rotary and core drilling, and other drilling operations and activities.

3. Implementation

Field Activities

Drill rig safety and maintenance is the responsibility of the drill rig operator. URS employees are responsible for their own safety including recognizing and avoiding drill rig hazards. URS employees that observe a drill rig condition believed to be unsafe shall advise the drill rig operator of the unsafe condition.

If the drilling firm is a subcontractor to URS, work will be stopped if conditions are determined to be unsafe.

4. Safety Guidelines

A. General Guidelines

URS technicians, geologists, engineers, or other field staff assigned to observe drilling operations or collect soil samples should observe the following guidelines:

Require a meeting at project start-up regarding the drill rig operator responsibility for rig safety and any site and equipment specific safety requirements

Set up any sample tables and general work areas for the URS field staff to the side of the drill rig (preferably 10 meters away) and not directly behind the rig.

URS engineers, technician, and geologists shall not assist the drillers with the drilling equipment or supplies and shall not at any time operate the drill rig controls.

B. Movement of Drill Rigs

Before moving a rig, the operator must do the following:

To the extent practical, walk the planned route of travel and inspect it for depressions, gullies, ruts, and other obstacles.

Check the brakes of the truck/carrier, especially if the terrain along the route of travel is rough or sloped.

Discharge all passengers before moving on rough or steep terrain.

Engage the front axle (on 4x4, 6x6, etc. vehicles) before traversing rough or steep terrain.

Driving drill rigs along the sides of hills or embankments should be avoided; however, if side-hill travel becomes necessary, the operator must conservatively evaluate the ability of the rig to remain upright while on the hill or embankment. The possibility must be considered that the presence of drilling tools on the rig may reduce the ability of the rig to remain upright (raises the center of mass of the rig).

Logs, ditches, road curbs, and other long and horizontal obstacles should be normally approached and driven over squarely, not at an angle.

When close lateral or overhead clearance is encountered, the driver of the rig should be guided by another person on the ground.

Loads on the drill rig and truck must be properly stored while the truck is moving, and the mast must be in the fully lowered position.

After the rig has been positioned to begin drilling, all brakes and/or locks must be set before drilling begins. If the rig is positioned on a steep grade and leveling of the ground is impossible or impractical, the wheel of the transport vehicle should be blocked and other means of preventing the rig from moving or topping over employed.

C. Buried and Overhead Utilities

The location of overhead and buried utility lines must be determined before drilling begins, and the locations should be noted on boring plans and/or assignment sheets.

When overhead power lines are close by, the drill rig mast should not be raised unless the distance between the rig and the nearest power line is at least 20 feet (7 meters) or other distance as required by local ordinances, whichever is greater. The drill rig operator or assistant should walk completely around the rig to make sure that proper distance exists.

When the drill rig is positioned near an overhead line, the rig operator should be aware that hoist lines and power lines can be moved towards each other by wind. When necessary and approved by the Project Manager (PM), the utility and/or power lines may be shielded, shut down, or moved by the appropriate personnel.

For additional information, please refer to SMS 34 "Utility Clearances and Isolation".

D. Clearing the Work Area

Before a drill rig is positioned to drill, the area on which the rig is to be positioned should be cleared of removable obstacles and the rig should be leveled if sloped. The cleared/leveled area should be large enough to accommodate the rig and supplies.

E. Safe Use of Augers

Never place hands or fingers under the bottom of an auger flight or drill rods when hoisting the augers or rods over the top of another auger or rod in the ground or other hard surfaces, such as the drill rig platform.

Never allow feet to get under the auger or drill rod while they are being hoisted.

When the drill is rotating, stay clear of the drill string and other rotating components of the drill rig. Never reach behind or around a rotating auger for any reason.

Move auger cuttings away from the auger with a long-handled shovel or spade; never use hands or feet.

Never clean an auger attached to the drill rig unless the transmission is in neutral or the engine is off, and the auger has stopped rotating.

Do not wear loose clothing or jewelry while working near the drill rig. Long hair must be pulled back to avoid entanglement with moving parts.

Hearing protection is required when working near an operating drill rig.

F. Safe Use of Hand Tools

Regulations regarding hand tools should be observed in addition to the guidelines provided below:

Each tool should be used only to perform tasks for which it was originally designed.

Damaged tools should be repaired before use or discarded.

Safety goggles or glasses should be worn when using a hammer or chisel. Nearby co-workers and by-standers should be required to wear safety goggles or glasses also, or move away.

Tools should be kept cleaned and stored in an orderly manner when not in use.

G. Safe use of Wire Line Hoists, Wire Rope, and Hoisting Hardware

Safety rules described in Title 29 Code of Federal Regulations (CFR) 1926.552 and guidelines contained in the Wire Rope User's Manual published by the American Iron and Steel Institute shall be used whenever wire line hoists, wire rope, or hoisting hardware are used. The driller should provide written reports (upon request) documenting inspections of equipment.

H. Traffic Safety

Drilling in streets, parking lots or other areas of vehicular traffic requires definition of the work zones with cones, warning tape, etc. and compliance with local police requirements. Refer to SMS 32 "Work Zone Traffic Control".

I. Fire Safety

Fire extinguishers (type ABC) shall be kept on or near drill rigs for fighting small fires.

If methane or other flammable gases or vapors are suspected in the area, a combustible gas indicator (CGI) shall be used to monitor the air near the borehole with all work to stop at 20 percent of the Lower Explosive Limit (LEL).

Work shall stop during lightning storms.

J. Drilling at Potential MEC/UXO Sites

If the project site is suspected of munitions and explosives of concern (MEC) or unexploded ordnance (UXO) contamination, the UXO team will conduct a reconnaissance and MEC/UXO avoidance to provide clear access routes to each site prior to drilling crews entering the area. The following procedures will be implemented:

Drilling operations on MEC/UXO sites will not be conducted until a complete plan for the site is prepared and/or approved by the URS

UXO Safety Officer. MEC/UXO avoidance must be conducted during drilling operations on known or suspect MEC/UXO sites (SMS-039).

The UXO team will identify, and clearly mark the boundaries of a clear approach path for the drilling crews, vehicles, and equipment to enter the site. This path will be, at a minimum, twice the width of the widest vehicle. No personnel will be allowed outside any marked boundary.

If MEC/UXO is encountered on the ground surface, the UXO team will clearly mark the area where it is found, report it to the proper authorities, and divert the approach path around it.

The UXO team will conduct an access survey using the appropriate geophysical instrument over the approach path for avoidance of MEC/UXO that may be in the subsurface. If a magnetic anomaly is encountered, it will be assumed to be MEC/UXO and the approach path will be diverted around the anomaly. UXO personnel only will operate the appropriate geophysical instrument and identify MEC/UXO.

An incremental geophysical survey of the drill hole location(s) will be initially accomplished by the UXO team using a hand auger to install a pilot hole. If MEC/UXO is encountered or an anomaly cannot be positively identified as inert material, HTRW sampling personnel will select a new drill hole location.

Once a drilling site has been surface cleared and a pilot hole established as described above, the drilling contractor will be notified that the site is available for subsurface drilling.

Additional guidance for MEC/UXO support during drilling activities is provided in URS SMS 039.

K. Protective Gear

1. Minimum Protective Gear

Items listed below should be worn by all staff working within 30 feet (10 meters) of drilling activities.

Hearing Protection;

Hard Hat;

Eye Protection (safety glasses, goggles, or face-shield)

Safety Shoes (shoes or boots with steel toes)

2. **Other Gear**

Items listed below should be worn when conditions warrant their use. Some of the conditions are listed after each item.

Safety Harnesses and Lifelines: Safety harnesses and lifelines shall be worn by all persons working on top of an elevated derrick beam or mast. The lifeline should be secured at a position that will allow a person to fall no more than six feet (2 meters). OSHA Fall Protection (1926 Subpart M) requirements apply.

Life Vests: Use for work over water.

5. Resources

A. International Association of Drilling Contractors Safety Alerts http://iadc.org/alerts.htm

B. Fall Protection - SMS 040

C. Hearing Conservation - SMS 026

D. Subcontractor Health and Safety Requirements - SMS 046

E. Utility Clearances and Isolation - SMS 034

F. Munitions Response / Munitions and Explosives of Concern - SMS 039

URS SAFETY MANAGEMENT STANDARD

Vehicle Safety Program

1. Applicability

This procedure applies to URS Corporation's U.S. operations.

This Safety Management Standard (SMS) applies to employees operating motor vehicles that are owned, rented or leased by the Company, and the use of personal vehicles while on Company business.

This SMS does not apply to heavy equipment operations (see SMS 019).

2. Purpose and Scope

This Safety Management Standard sets for the policies that will help URS minimize losses, injuries, and legal liabilities associated with improper vehicle use.

3. Implementation

The overall responsibility for program implementation is with the URS Office Manager. Other responsibilities include:

Administration -	Fleet management, participation in the Vehicle Safety Program, vehicle acquisition, insurance claims reporting, controlling access to vehicles, maintenance of vehicles, participating on accident review processes.
Human Resources -	Documentation of driver's license annually, participation in the accident review processes.
Health and Safety -	Employee safety training, maintenance of the vehicle safety program, and participation in the accident review processes.
Employee -	Familiarization with URS Vehicle Safety Program and compliance with its requirements.

4. Requirements

A. Authorized Drivers

1. Authorized Drivers are those individuals permitted to drive URS owned, leased, or rented vehicles, and employees driving a personal vehicle for work purposes being reimbursed mileage.

2. Must be at least 18 years of age (non-commercial license) or 21 years of age (commercial license) and have a current driver's license for the appropriate class of vehicle (unless more stringent requirements are established by the leasing/renting agency).

3. Human Resources / Administration will annually obtain and review a copy of the state issued drivers license for all Authorized Drivers. The Operating Unit Manager shall audit this function annually. URS

employees that are Authorized Drivers shall provide a copy of their driver's license upon request. Authorized drivers who lose their license through legal action ***must*** notify their Human Resources Representative immediately. The Human Resources Representative will notify the Fleet Manager.

4. Authorized drivers must:

    a. Review the Vehicle Safety Program (SMS 057) and sign the Drivers Information form (Attachment 57-2) annually.

    b. Report any conviction for driving under the influence of drugs or alcohol to the HR representative responsible for your office or operation.

    c. Complete vehicle safety training; URS web-based training module, or other sanctioned driving courses described in section - 4.B. Training.

    d. Report all accidents. If the authorized driver has an accident in a URS owned, rented or leased vehicle, the accident must be reported immediately to the Office Manager. The SMS 57-1 form must be completed and submitted to the URS Fleet Manager (see 57-1 for reporting instructions).

    e. Cooperate with any URS investigation concerning the accident.

    f. Complete remedial driver safety training described in 4.B.2 as appropriate following an accident.

5. Non-URS employees (e.g., subcontractors, alliance partners) may operate URS vehicles only when this activity is specifically agreed to in the applicable contract, and only within the parameters of the contract and project plans.

6. URS operations or offices that plan vehicle use that requires compliance with Federal motor carrier regulations, the affected Office Manager must obtain approvals from the URS Health and Safety Director and the URS Fleet Manager. This requirement typically applies to vehicles with a gross vehicle weight over 10,000 pounds or vehicles used for hazardous materials transport. The driver must have an appropriate commercial driver's license and may be subject to medical surveillance (see SMS 24).

7. Only Authorized Drivers can be reimbursed mileage for the use of their person vehicle on company business. Requests for reimbursements for mileage by non-designated drivers shall be denied.

B. Training

1. Authorized Drivers shall be provided basic driver safety training, including a review of the URS Vehicle Safety Program (SMS 057) and the on-line training, within 6 months of the effective date of this SMS or within 3 months of their hire date. Other training may be substituted for the on-line training if approved by the URS Regional Health and Safety Manager. Alternative training may include commercially available driver safety videos, presentations by local law enforcement officers, or training by the URS Regional Health and Safety Manager.
2. Additional training is required for employees that have been involved in a vehicle accident where $2,000 in damages was sustained or when the accident includes a police citation. This additional training will be in the form of a 4-hour web-based training provided through the National Safety Council. The site is located at http://www.safetyserve.com/urscorp. Use **URSDDC** as the access code.
3. All Authorized Drivers who drive permanently assigned URS owned or leased vehicles are required to complete the 4-hour National Safety Council web based training at the web site in the above paragraph.

C. General Operating Policy and Procedure (Applies to Authorized and Non-Authorized Drivers Operating Motor Vehicles on Official Company Business)

1. Only properly licensed employees who are specifically authorized to drive Company vehicles may operate company owned/rented/leased motor vehicles.
2. Authorized drivers required to operate vehicles with special hazards (i.e. trucks carrying fuel cells, vehicles used to tow trailers, vehicles with limited visibility, etc.) shall be thoroughly briefed on the hazards and control measures necessary for safe operation of the vehicle. The local office shall maintain documentation of the briefing.
3. Drivers/operators shall know and obey all federal, state and local motor vehicle laws applicable to the operation of their vehicle.
4. A driver shall not permit unauthorized persons to operate a URS owned/rented/leased vehicle.
5. URS policy regarding reimbursement and insurance coverage requirements for use of personal automobiles may be found in the Policy and Procedures Manual (Section 074.020). Only Authorized Drivers may be reimbursed mileage for the use of a personal vehicle.
6. All cargo extending 4 feet or more beyond the end of a truck, trailer or similar vehicle shall be clearly marked with a red warning flag or cloth measuring no less than 16 inches square. Red lights must be used at night.
7. Company owned/rented/leased vehicles are for official business use only and are not to be used for personal activities without the specific approval of a Division Manager, Senior Vice President, or the URS Fleet Manager.

8. Seat belts and shoulder harnesses (occupant restraint systems) shall be worn or used whenever the vehicle is in operation. The vehicle may not move until all passengers have fastened their restraints.
9. When parking or leaving a vehicle, the following procedures must be followed: Shut off the engine, engage the transmission in park (automatic transmission) or first gear (standard transmission), set the parking brake, remove the ignition keys, and lock the vehicle.
10. The vehicle's engine is to be turned off during refueling. Smoking or cell phone use is not allowed while refueling.
11. Drivers/operators will not drive or operate vehicles while under the influence of alcohol or illegal drugs. Further details on the URS Substance Abuse Policy may be found in the Policy and Procedure Manual (section 034.030).
12. Drivers/operators will not drive or operate vehicles while under the influence of medications when told by a physician, another healthcare provider, or the manufacturer (i.e. instructions on the label) that the activity is unsafe.
13. Vehicle operators are responsible for any fines levied by law enforcement agencies for the operation of their vehicles.
14. Driver/operators may not deactivate or muffle any backup warning device.
15. Distractions while driving are a major cause of accidents. Distractions include the use of cellular phones, eating, and engaging in intense conversations. URS Authorized drivers must exercise proper control of the vehicle at all times, including the management of possibly distracting actions and behaviors. The use of hands-free devices for the cell phones is required. If you need to make a call on a cell phone, have a colleague dial the number or pull over and park in a safe area. If you have to eat, pull over and park. If you become engaged in an intense conversation to the point of distraction, pull over and park or end the conversation.

D. Field Site Vehicle Safety

1. Define specific vehicle travel routes and parking areas at field sites. Use fencing, cones or other markings to define roads and parking. SMS 32 provides additional information on Work Zone Traffic Control.
2. If parking on the shoulder of an active road, park as far off the road as possible.
3. If work is required alongside an active road (e.g., surveying) park the vehicle behind the area of work to provide a barrier against out-of-control vehicles.
4. URS will not transport DOT-placard quantities of hazardous materials. However, small quantities of hazardous materials (e.g., sample coolers) may be transported if properly packaged. Be careful to prevent chemical contamination of the vehicle. Further details on DOT shipping may be found in the DOT Shipping SMS 048.

5. Nuclear density meters (e.g., Troxler units) may be transported only by employees who have been trained in the use of nuclear density meters (see SMS 044). Nuclear density meters must be secured from movement and locked during transport. NRC and state-specific regulations regarding transport documentation also apply.
6. When performing fieldwork requiring the blocking of traffic lanes (e.g., bridge inspection), follow URS SMS 032, the Manual on Uniform Traffic Control Devices for Streets and Highways (ANSI D6.1) and local police requirements for barriers, cones, and flaggers.
7. No employee may ride in the bed of a pickup truck unless seating and restraints are provided for this specific use.
8. Articles, tools, equipment, etc. placed in vehicles shall be stored as not to interfere with vision or the proper operation of the vehicle in any way. This also includes preventing items from flying about or out of the vehicle during sudden stops, turning, etc.
9. Trucks or vehicles with obstructed rear-view mirrors must observe the following procedures when backing up: Position an employee to act as a spotter at the rear of the vehicles, in the driver's line of sight, to ensure that the area behind the truck is clear. If no other employee is present, then the driver must step out of the vehicle and check the area behind the vehicle before backing up. As an added precaution, avoid backing up whenever possible.

E. Accident Response and Reporting

1. In case of injury, call or have someone else call, 9-1-1 immediately for emergency assistance. If you are involved in an accident and are not injured, do the following:
   a. Protect the accident scene.
   b. Do not admit liability or place any blame for the accident.
   c. Provide only your name, address, driver's license number, and vehicle insurance information.
   d. Obtain the following:
      i. name(s), addresses, and telephone number(s) of the owner
      ii. driver and occupants of other vehicle(s)
      iii. the owner's insurance company
      iv. driver's license number
      v. year, make, model and license number of the vehicle(s)
      vi. name(s) and addresses of any witnesses

e. **DO NOT:**

Call the insurance company; the Fleet Manager's office will do this (unless the incident involves your personal vehicle).

Give a statement to the press.

Give a signed statement to the claims adjuster representing the other driver's insurance company.

NOTE: The Auto Claim Report (Attachment 57-1) for Company-leased or owned vehicles is located in the vehicle glove compartment. The driver must complete this form at the scene of the accident and submit it to management along with a copy of the most recently submitted SMS 57-2 Driver's Information form.

2. Notification

All accidents with a Company-leased, rented, or owned vehicle must be reported to your Office/Branch Manager/Supervisor and Fleet Manager within 24-hours of the time it occurs. Use the Auto Claim Report (Attachment 57-1) for this purpose. The Fleet Administrator will report the accident to the insurance carrier (leased and owned vehicles only) promptly.

F. Accident Review

1. A violation of the policy in this Vehicle Safety SMS is subject to disciplinary action up to and including termination. The Fleet Manager will review all accidents involving URS-owned, rented or leased vehicles.

2. The Company may suspend the privilege to operate vehicles on Company business due to non-compliance with the URS Vehicle Safety Program, involvement in a motor vehicle accident, or resulting citations or other legal actions associated with motor vehicle violations. Personnel authorized to suspend an employee's status as an Authorized Driver include:

   a. A Project Manager with responsibility for dedicated vehicles on a site. The suspension is applicable to those site vehicles only.

   b. A URS Operations Manager responsible for the employee.

   c. The URS Fleet Manager.

   d. The URS Health and Safety Director.

3. The employee's driving privileges ***will be*** suspended for any of the following:

   a. Accidents or legal action involving alcohol or drug use (e.g., DUI).

   b. Driving without a license.

c. Hit-and-run driving / leaving the scene of an accident.

d. Unauthorized use of Company vehicles (i.e. using a company vehicle for moving personal items, carrying passengers who are not associated with work activities, etc...).

4. The employee's driving privileges ***may be*** suspended for any of the following:

   a. Two or more accidents involving the same Authorized Driver within a 12 month period

   b. Multiple speeding tickets or multiple citations for violations of the motor vehicle code.

   c. Multiple complaints from other employees or members of the public about driving performance.

   d. Any accident caused by a URS Authorized Driver where damages exceed $2,000.

5. An Authorized Driver's driving privileges may be reinstated if:

   a. For any suspension resulting from law enforcement agency legal action involving drugs and alcohol on the part of the former Authorized Driver– the driving privileges may be reinstated only by concurrent agreement from the Operating Unit Manager, the URS Fleet Manager, the URS Health and Safety Director, and the appropriate Human Resources Regional Manager.

   b. For those Authorized Driver's privilege suspensions that are not related to driving under the influence of drugs or alcohol, privileges may be reinstated with concurrent agreement by the URS Operating Unit Manager and the URS Health and Safety Director upon completion of required remedial training (see section 4.B.2 of this SMS).

6. Disciplinary action includes possible:

   a. Loss of URS driving privileges

   b. Additional driver safety training (required for accidents resulting in more that $2,000 in damages – optional for all other accidents).

   c. Suspension without pay

   d. Termination

G. Inspection

1. The driver is responsible for inspecting the vehicle prior to use and not driving a vehicle with obvious safety defects.

2. Basic safety checks must include:

a. Tire condition/pressure
b. Lights/turn signals
c. A clean windshield and adequate window washer fluid
d. Gauges/warning lights indicating a normal condition
e. Mirrors properly adjusted
f. Brakes with adequate pedal pressure for proper braking
g. Any defects must be reported to the local office Fleet Representative/Office Administrator.
h. Vehicle Maintenance
i. The Office Administrator (or designee) is to ensure that all URS-leased/owned vehicles are properly maintained.
j. Routine maintenance must be performed in accordance the schedule provided in the owner's manual stored in the vehicle.
k. Reported defects/problems with vehicles must be repaired promptly.

5. Documentation Summary

A. Auto Claim Report - (Attachment SMS 57-1)

B. Driver's Information - (Attachment SMS-57-2)

6. References

The following sites provide additional information to assist you:

A. National Safety Council; Information on Defensive Driving Courses
http://www.nsc.org/psg/ddc.htm

B. AAA Foundation for Traffic Safety
http://www.aaafts.org/

C. 4-Hour Defensive Driver Training
http://www.safetyserve.com/urscorp password: URSDDC

URS	Health, Safety and Environment **AUTO CLAIM REPORT**	Attachment 57-1 Page 1 of 2

To be used for **all** vehicle accidents involving URS-leased/rented/owned vehicles and for personal vehicles used on company business.

Name of Employee Involved in Accident _____

Office Location _____

Contact Person _____

Phone Number _____

Fax Number _____

Company Vehicle

URS	Health, Safety and Environment **DRIVERS INFORMATION**	Attachment 57-2

Policy

All Company employees who operate a vehicle on company business must comply with the URS Vehicle Safety Program (SMS 57). Violation of this policy is subject to disciplinary action up to and including termination.

License

I currently have a valid driver license and authorize URS, its agents, or insurance carrier to verify my motor vehicle record.

I agree to notify URS Administration immediately if my driver's license is suspended or revoked.

Please Print Legibly

Name _____ _____ _____ Date of Birth _____
First Middle Last

License Number _____ State _____ Class _____

Employee Signature _____ Date _____

Repeated accidents, loss of driver's license, or violation of URS' Vehicle Safety Program will result in loss of permission to drive on Company business.

(Attach the applicant's driver's license to this space and photocopy this sheet. All information on the license must be legible after photocopying.)

URS	Health, Safety, and Environment **ACCIDENT REVIEW & CLASSIFICATION CHECKLIST**	Attachment 57-3

The Accident Review Committee may use this checklist as a guide for determining if the accident was **preventable** or **non-preventable.**

If the answer to any of the following questions is "no", our driver failed to make the correct decisions and contributed to the accident. Please check the appropriate answer.

	YES	NO
INTERSECTIONS		
Did our driver approach the intersection at a controlled speed that was reasonable for the conditions?		
Was our driver prepared to stop before entering the intersection?		
Did our driver make certain the other driver was stopping for a traffic light or stop sign?		
Did our driver obey all traffic signs?		
Did our driver signal well in advance of his/her change in direction?		
Did our driver turn from the proper lane?		
Was he/she alert for the turns of other vehicles?		
Did he/she avoid overtaking and passing in the intersection?		
Did he/she refrain from jumping the green signal?		
Did our driver refrain from attempting to pass through on a late yellow or an early red signal?		
Did he/she follow the precautionary steps required when approaching a flashing red or yellow signal?		
Did our driver pull out slowly at a blind corner, prepared to stop his/her vehicle if necessary?		
REAR ENDED OTHER VEHICLE		
Was our driver maintaining a safe following distance for speed, traffic and weather conditions?		
Did he/she approach the green traffic light cautiously, expecting the driver ahead to stop suddenly on a signal change?		
Did he/she allow the driver ahead to develop adequate space before moving ahead from a standing start?		
Did he/she keep from skidding?		
BACKING		
Was it necessary to back?		
Did our driver have to park so close to the vehicle ahead as to require backing to leave the parking space?		
Was it necessary to drive into the narrow street, dead-end alley or driveway from which he/she backed?		
If he/she could not see where they were backing:		
Did he/she try to get someone to guide them?		
Did our driver look all around the vehicle before getting in?		
Did he/she back immediately after looking?		
Did he/she use the horn while backing?		
Did our driver look to the rear without depending on the rear vision mirror?		
If the distance was long, did he/she stop, get out and look around occasionally?		

URS	Health, Safety, and Environment **ACCIDENT REVIEW & CLASSIFICATION CHECKLIST**	Attachment 57-3

	YES	NO
Did he/she back slowly?		
Did our driver judge backing clearance accurately?		
PULLING OUT FROM THE CURB		
Did our driver look to the rear and front for approaching traffic immediately before starting to pull out?		
Did he/she look back rather than depend upon rear vision mirror?		
Did he/she signal before pulling from curb?		
Did our driver start out only when his/her action would not require traffic to change its speed or direction to avoid him/her?		
Did he/she continue to glance back as he/she pulled out?		
SKIDDING		
Was our driver driving at a speed safe for condition of weather and road? (i.e., fog, steam, dust)		
Was he/she keeping a safe following distance?		
Was he/she expecting ice on and under bridges, in gutters, ruts and near the curb?		
Was he/she alert for melting snow, freezing in the shade, loose gravel, sand, ruts, etc.?		
Did he/she keep out of rail tracks and cross them at wide angles?		
Were the steering and braking actions proper?		
PASSING		
Did our driver see enough clear space beyond the vehicle ahead to make the pass safely?		
Did he/she build up enough acceleration before starting the pass to ensure that he would not remain in the oncoming lane unduly long on a two lane road?		
Did he/she stay inside the no-passing lane markings?		
Did our driver allow enough clearance before pulling back into the right lane?		
HEAD-ON COLLISION: OUR DRIVER'S ACTIONS		
If there was early indication of erratic driving by the oncoming operator, did our driver immediately begin evasive action?		
Did he/she blow the horn and flash the lights?		
Did he/she slow down quickly and drive to the extreme right side of the road and stop?		
PEDESTRIANS		
Did our driver pass through congested sections anticipating that pedestrians might step in front of the vehicle?		
Did he/she keep as much clearance between the vehicle and parked cars as safety permitted?		
Did he/she refrain from passing vehicles that had stopped to allow pedestrians to cross?		
Did he/she check the location of pedestrians before starting on the green signal or riding through on a yellow clearance indication?		
Was our driver aware of groups of children and prepared to stop in the event one ran into the street suddenly?		
Did he/she give all pedestrians the right of way?		
Did he/she tap the horn to alert the pedestrian of his/her approach?		
Did he/she refrain from passing a school bus which was stopped?		

URS	Health, Safety, and Environment **ACCIDENT REVIEW & CLASSIFICATION CHECKLIST**	Attachment 57-3

	YES	NO
PARKED		
Was our driver parked on the proper side of the road?		
Was it necessary to park near the intersection?		
Did he/she have to park on the traveled portion of the highway, on the curve, or on the hill?		
Did he/she park parallel to curb and not more than I S" from it?		
Was it necessary to park close to an alley or directly across from a driveway?		
MISCELLANEOUS/OTHER CONSIDERATIONS		
Collision with train		
Our driver fell asleep		
Hit stationary object (other than listed previously)		
Open load fell off (not properly secured or regularly checked en route)		
Vehicle door(s) flew open en route, struck other vehicle, or cargo fell out and caused accident to following vehicle (usually applicable)		
Visibility obstructed by fog, steam or bad weather conditions		

NOTES: _____

_____

_____

_____

_____

_____

Accident Review Committee Members: _____

_____ _____

_____ _____

_____ _____

_____ _____

Employee Reviewed: _____

Date of Review: _____ **Accident Date:** _____

3

URS SAFETY MANAGEMENT STANDARD
Cold Stress

1. Applicability

This procedure applies to URS projects where field crews are working outdoors in damp and cool (below 50° F or 10°C) conditions or anytime temperatures are below 32°F or 0°C.

2. Purpose and Scope

The purpose of this procedure is to protect project personnel from the following conditions:

Hypothermia: Hypothermia results when the body loses heat faster than it can be produced. When this situation first occurs, blood vessels in the skin constrict in an attempt to conserve vital internal heat. Hands and feet are first affected. If the body continues to lose heat, involuntary shivers begin. This is the body's way of attempting to produce more heat, and it is usually the first real warning sign of hypothermia. Further heat loss produces speech difficulty, confusion, loss of manual dexterity, collapse, and finally death. Wet clothes or immersion in cold water greatly increases the hypothermia risk. The progressive clinical presentation of hypothermia may be seen in Attachment 59-1.

Frostbite: Local injury resulting from cold is included in the generic term frostbite. There are several degrees of damage. Frostbite can be categorized into:

Frost Nip or Initial Frostbite: (1st degree frostbite) Characterized by blanching or whitening of skin.

Superficial Frostbite: (2nd degree frostbite) Skin has a waxy or white appearance and is firm to the touch, but tissue beneath is resilient. Blistering and peeling of the frozen skin will follow exposure.

Deep Frostbite: (3rd degree frostbite) Tissues are cold, pale, and solid; extremely serious injury with possible amputation of affected area.

Frostbite can occur without hypothermia when the extremities do not receive sufficient heat. The toes, fingers, cheeks, and ears are the most commonly affected. Frostbite occurs when there is freezing of the fluids around the cells of the affected tissues. The first symptom of frostbite is an uncomfortable sensation of coldness, followed by numbness. There may be tingling, stinging, or cramping. Contact by the skin with tools or other metal objects below 20°F (-7°C) may result in contact frostbite.

3. Implementation

Field Activities - Implementation of this procedure is the responsibility of the Project Manager and the field supervisor.

4. Requirements

A. Carefully plan work anticipated to be performed in cool or cold conditions. Include costs in project budgets for specialized equipment and supplies needed to complete the field activities.

B. Monitor weather forecasts immediately prior to entering the field.

C. Observe and monitor weather conditions such as ambient temperature, wind speed, and precipitation while in the field. Use Attachment 59-2 to determine wind chill.

D. Wear at least 3 layers of clothing.

An outer layer to break the wind and allow some ventilation (e.g., Gortex® or nylon)

A middle layer of down, wool, or similar materials to provide insulation

An inner layer of cotton or synthetic weave to allow ventilation

In addition:

Wear a hat. Up to 40% of body heat can be lost when the head is left exposed.

Wear insulated boots or other insulated footwear.

Keep a change of dry clothing available in case work clothes become wet.

Do not wear tight clothing. Loose clothing allows better ventilation.

E. Use the following work practices:

Use Attachment 59-3 to establish work/rest cycles in cold weather.

Drink plenty of warm liquids. It is easy to become dehydrated in cold

weather.

Avoiding caffeine and alcohol. Alcohol will accelerate loss of body heat.

Eat high calorie snacks to help maintain body metabolism.

If possible, heavy work should be scheduled during the warmer parts of the day. Take breaks out of the cold.

Work in pairs to keep an eye on each other and watch for signs of cold stress.

NEVER IGNORE SHIVERING. Persistent or violent shivering is a clear warning that you are on the verge of hypothermia.

Avoid exhaustion.

F. When possible, use the following engineering controls:

Provide shelter to escape cold, wind and precipitation

Provide a source of heat (such as warm packs or portable heaters)

Use insulating materials on equipment handles when temperatures drop below 30°F or -1°C.

G. Watch for symptoms and signs of hypothermia (see Attachment 59-1).

H. Treat cold stress illness as follows:

Hypothermia: Prompt treatment of hypothermia is essential. Once the body temperature drops below 95°F or 35°C, the loss of temperature control occurs, and the body can no longer rewarm itself. Initial treatment includes reducing heat loss by moving the individual out of the wind and cold, removal of wet clothing, applying external heat (such as a pre-warmed sleeping bag, electric blanket, or body-heat from other workers) and follow-up medical attention.

Frost Bite: The initial treatment for frostbite includes bringing the individual to a warm location, removal of clothing in the affected area, and, **if help is delayed**, placing the affected parts in warm (100° to104° F or 38° to 40°C) water. Do not massage or rub the frostbite area. After

the initial treatment, wrap the affected area loosely in sterile gauze and seek medical attention.

For further discussion on Cold Stress treatment, please refer to Attachment 59-1

I. Hypothermia in Water:

Loss of body heat to the water is a major cause of deaths in boating accidents. Often the cause of death is listed as drowning; however the primary cause is often hypothermia. It should also be noted that alcohol lowers the body temperature around two to three degrees by dilating the blood vessels. Do not drink alcohol around cold water. The following table shows the effects of hypothermia in water:

WATER TEMPERATURE	EXHAUSTION	SURVIVAL TIME
32.5° F (0°C)	Under 15 min.	Under 15 to 45 min.
32.5 to 40°F (0 – 4°C)	15 to 30 min.	30 to 90 min.
40 to 50°F (4 – 10°C)	30 to 60 min.	1 to 3 hrs.
50 to 60°F (10 – 16°C)	1 to 2 hrs.	1 to 6 hrs.
60 to 70°F (16 – 21°C)	2 to 7 hrs.	2 to 40 hrs.
60 to 70°F (16 – 21°C)	3 to 12 hrs.	3 hrs. to indefinite
Over 80°F (27°C)	Indefinite	Indefinite

SOME POINTS TO REMEMBER:

Wear your PFD. Review SMS 053 - Marine Safety and Boat Operations.

If water is less than 50°F (10°C), wear a wet suit or dry suit for work in water (e.g., wading) or if significant potential to fall in water.

While in the water, do not attempt to swim unless to reach nearby safety. Unnecessary swimming increases the rate of body heat loss. Keep your head out of the water. This will increase your survival time.

Keep a positive attitude about your rescue. This will increase your chances of survival.

If there is more than one person in the water, huddling is recommended.

J. Training

Workers at risk of developing hypothermia or cold-related injury will be trained in:

recognition of the signs and symptoms of cold injury or impending hypothermia,

proper re-warming procedures and appropriate first aid treatment,

proper use of clothing,

proper eating and drinking practices

safe work practices appropriate to the work that is to be performed.

5. Documentation Summary

File these records in the Project Safety File.

A. Completed Project Hazard Analysis form (see Health and Safety Website – "Hazard Analysis")

B. Cold stress training records

6. Resources

A. OSHA Fact Sheets – "Protecting Workers in Cold Environments" http://www.osha-slc.gov/OshDoc/Fact_data/FSNO98-55.html

B. Attachment 59-1 "Signs of, and Treatment for, Cold Stress related Illnesses"

C. Attachment 59-2(a) "Wind Chill Index" (units in °F and miles/hour)

D. Attachment 59-2(b) "Wind Chill Index" (units in °C and Kilometers/hour)

E. Attachment 59-3 "TLVs Work/Warm-up Schedule for Outside Workers based on a Four-hour Shift"

F. OSHA Publication 3156 – Quick Reference Card http://www.osha.gov/Publications/osha3156.pdf

Attachment 59-1
Signs of and Treatment for Cold Stress Related Illnesses

Condition	Signs/Symptoms	Treatment
Hypothermia **Mild** (98° - 90° F) (36° - 32°C)	shivering lack of coordination stumbling, fumbling hands slurred speech memory loss pale, cold skin	move to warm area stay active remove wet clothes and replace with dry clothes or blankets cover the head drink warm (not hot) sugary drink
Hypothermia **Moderate** (90° - 86° F) (32° - 30°C)	shivering stops unable to walk or stand confused and irrational	All of the above, plus Call for an ambulance Cover all extremities completely Place very warm objects, such as hot packs or water bottles on the victim's head, neck, chest and groin
Hypothermia **Severe** (86° - 78° F) (30° - 26°C)	severe muscle stiffness very sleepy or unconscious ice cold skin death	Call for an ambulance Treat the victim very gently Do not attempt to re-warm -- the victim should receive treatment in a hospital
Frostbite	Cold, tingling, stinging or aching feeling in frostbitten area; numbness Skin color turns red, then purple, then white or very pale skin, cold to the touch Blisters in severe cases	Seek medical attention Do not rub the area Wrap in soft cloth If help is delayed, immerse in warm, not hot, water
Trench Foot	Tingling, itching or burning sensation Blisters	Soak feet in warm water, then wrap with dry cloth bandages Drink a warm, sugary drink

Source: Princeton University, Department of Environmental Health and Safety, posted 2/2/99.

Attachment 59-2(a)
Wind-Chill Index[1]
(miles per hour and °F.)

	ACTUAL THERMOMETER READING (F)									
	50	40	30	20	10	0	-10	-20	-30	-40
Wind speed in mph	EQUIVALENT TEMPERATURE (F)									
calm	50	40	30	20	10	0	-10	-20	-30	-40
5	48	37	27	16	6	-5	-15	-26	-36	-47
10	40	28	16	4	-9	-21	-33	-46	-58	-70
15	36	22	9	-5	-18	-36	-45	-58	-72	-85
20	32	18	4	-10	-25	-39	-53	-67	-82	-96
25	30	16	0	-15	-29	-44	-59	-74	-88	-104
30	28	13	-2	-18	-33	-48	-63	-79	-94	-109
35	27	11	-4	-20	-35	-49	-67	-82	-98	-113
40	26	10	-6	-21	-37	-53	-69	-85	-100	-116
Over 40 mph (little added effect)	Little Danger (for properly clothed person)				Increasing Danger (Danger from freezing of exposed flesh)			Great Danger		

[1] Source: Fundamentals of Industrial Hygiene, Third Edition. Plog, B.A., Benjamin, G.S., Kerwin, M.A., National Safety Council, 1988

Attachment 59-2(b)
Wind-chill Index[1]
(Kilometers per hour and °C.)

Estimated wind speed	Actual temperature reading (°C)												
	10	5	0	-5	-10	-15	-20	-25	-30	-35	-40	-45	-50
(in km/h)	Equivalent chill temperature (°C)												
0 (Calm)	10	5	0	-5	-10	-15	-20	-25	-30	-35	-40	-45	-50
8	9	3	-2	-7	-12	-18	-23	-28	-33	-38	-44	-49	-54
16	4	-2	-7	-14	-20	-27	-33	-38	-45	-50	-57	-63	-69
24	2	-5	-11	-18	-25	-32	-38	-45	-52	-58	-65	-72	-78
32	0	-7	-14	-21	-28	-35	-42	-50	-56	-64	-71	-78	-84
40	-1	-8	-16	-24	-31	-38	-46	-53	-60	-67	-76	-82	-90
48	-2	-10	-17	-25	-33	-40	-48	-55	-63	-70	-78	-86	-94
56	-3	-11	-18	-26	-34	-42	-50	-58	-65	-73	-81	-89	-96
64	-3	-11	-19	-27	-35	-43	-51	-59	-66	-74	-82	-90	-98
(Wind speeds greater than 64 km/h have little additional effect.)	LOW HAZARD Risk of exposed dry skin being affected in less than one hour. Awareness of hazard low.				INCREASING HAZARD Danger from freezing of exposed flesh within one minute.			HIGH HAZARD Flesh may freeze within 30 seconds.					

The table was originally developed by the U.S. Army Research Institute of Environmental Medicine, Natick, MA, and is adapted from the 1995-1996 *Threshold Limit Values for Chemical Substances and Physical Agents and Biological Exposure Indices,* published by the ACGIH. The ACGIH publication provides the equivalent table with temperature in degrees Fahrenheit and wind speed in mph.

Equivalent chill temperature requiring dry clothing to maintain core body temperature above 36°C (96.8°F).

Attachment-59-3

TLVs Work/Warm-up Schedule for Outside Workers based on a Four-hour Shift*

The ACGIH has adopted the guidelines developed by the Saskatchewan Labour for working outdoors in cold weather conditions. These guidelines recommend protective clothing and limits on exposure time. The recommended exposure times are based on the wind chill factor, a scale based on air temperature and wind speed. The work-break schedule applies to any four-hour period with moderate or heavy activity. The warm-up break periods are of 10-minute duration in a warm location. The schedule assumes that "normal breaks" are taken once every two hours. At the end of a 4-hour period, an extended break (e.g. lunch break) in a warm location is recommended. More information is available in the ACGIH publications "2000 TLVs and BEIs" and "Documentation of TLVs and BEIs" and on the Saskatchewan Labour web page "Cold Conditions Guidelines for Outside Workers".

Air Temperature - Sunny Sky		**No Noticeable Wind**		**5 mph Wind**		**10 mph Wind**		**15 mph Wind**		**20 mph Wind**	
°C (approx.)	°F (approx.)	Max. work Period	No. of Breaks**	Max. Work Period	No. of Breaks	Max. Work Period	No. of Breaks	Max. Work Period	No. of Breaks	Max. Work Period	No. of Breaks
-26° to -28°	-15° to -19°	(Norm breaks) 1		(Norm breaks) 1		75 min.	2	55 min.	3	40 min.	4
-29°to -31°	-20°to -24°	(Norm breaks) 1		75 min.	2	55 min.	3	40 min.	4	30 min.	5
-32° to -34°	-25°to -29°	75 min.	2	55 min.	3	40 min.	4	30 min.	5	Non-emergency work should cease	
-35° to -37°	-30° to -34°	55 min.	3	40 min.	4	30 min.	5	Non-emergency work should cease			
-38° to -39°	-35° to -39°	40 min.	4	30 min.	5	Non-emergency work should cease					
-40° to -42°	-40°to -44°	30 min.	5	Non-emergency work should cease							
-43° & below	-45° & below	Non-emergency work should cease									

*2000 TLVs and BEIs - Threshold Limit Values for Chemical Substances and Physical Agents and Biological Exposure Indices. Cincinnati : American Conference of Governmental Industrial Hygienists (ACGIH), 2000 - page 176. Adopted from Saskatchewan Labour "Cold Conditions Guidelines for Outside Workers"

URS SAFETY MANAGEMENT STANDARD
HAND SAFETY

1. Applicability

This program applies to URS Corporation office and field operations where hand safety is a concern.

2. Purpose and Scope

This procedure is intended to protect employees from activities that might or could expose them to injury. This procedure provides information on recognizing those conditions that require personal protective equipment or specific work practices to reduce hand injury risk.

3. Implementation

Office locations: The implementation of this program is the Office Manager's responsibility, with support from the URS Local Health and Safety Representative.

Field Activities: Implementation of this program is the Project Manager(s)' responsibility.

4. Requirements

A. Personal Protective Equipment

1. Perform hazard assessments for those work activities likely to require PPE.

   a. Use SMS 29-1 (PPE Hazard Assessment Certification Form) to perform the assessment. The Hazard Assessment Certification Form shall accompany URS personnel at job sites for use in the event of a job or task change.

   b. Reevaluate completed hazard assessments when the job or task changes.

2. If possible, eliminate the hazards identified through engineering or administrative controls. Examples of controls are: chemical substitution, machine guarding, and use of different tools.

3. Select PPE that will protect employees if hazards cannot be eliminated.

   a. Review Material Safety Data Sheets for project or task-specific chemicals to determine appropriate PPE. If needed, consult with the URS Health and Safety Representative for assistance.

b. Review glove manufacturer recommendations for both physical and chemical protection.

c. Obtain gloves of the correct size for project field staff

d. When both chemical and physical protection are of concern, the chemical protection gloves (e.g. nitrile) shall be worn inside the physical protection gloves (e.g. leather, Kevlar®).

e. Latex gloves are not recommended for chemical protection.

B. Guidelines for Working With and Around Equipment (Hand Tools, Portable Equipment)

1. General

a. Keep hand and power tools in good repair and used only for the task for which they were designed.

b. Remove damaged or defective tools from service.

c. Do not remove or bypass a guarding device for any reason.

d. Keep surfaces and handles clean and free of excess oil to prevent slipping.

e. Wear proper PPE, including gloves, as necessary.

f. Do not carry sharp tools in pockets.

g. Clean tools and return to the toolbox or storage area upon completion of a job.

h. Wrenches must have a good bite before pressure is applied.

i. Brace yourself by placing your body in the proper position so that in case the tool slips you will not fall.

ii. Make sure hands and fingers have sufficient clearance in the event the tool slips.

iii. Always pull on a wrench, never push.

i. When working with tools overhead, place tools in a holding receptacle when not in use.

j. Do not throw tools from place to place, from person to person, or drop from heights.

k. Inspect all tools prior to start-up or use to identify any defects.

l. Powered hand tools should not be capable of being locked in the on position.

m. Require that all power-fastening devices be equipped with a safety interlock capable of activation only when in contact with the work surface.

n. Do not allow loose clothing, long hair, loose jewelry, rings and chains to be worn while working with power tools.

o. Do not use cheater pipes.

p. Make provisions to prevent machines from restarting through proper lockout/tagout (refer to SMS 023 – Lockout and Tagout Safety).

2. Cutting Tools

a. Hand cutting tools such as knives, scissors, paper cutters, etc. should be used with care and in the manner intended by the manufacturer.

b. Personnel when utilizing cutting tools should observe the following precautions to the fullest extent possible:

i. Use the correct tool and correct size tool for the job,

ii. Cut in a direction away from yourself and not towards other workers in the area,

iii. Maintain the non-cutting hand and arm towards the body and out of the direction of cutting tool if it were to slip out of the material being cut.

iv. Ensure that the tool is sharp and clean; dirty and dull tools typically cause poor cuts and more hazard than a sharp clean cutting tool

v. Store these tools correctly with covers in-place or blades retracted as provided by the manufacturer.

vi. On tasks where cutting may be very frequent or an all day task (e.g., liner samples), Kevlar® gloves should be considered in the PPE evaluation for the project.

vii. Do not remove guards on paper cutters.

3. Moving/Rotating Equipment

a. General Requirements for Drilling

i. Require a meeting at project start-up regarding the drill rig operator responsibility for rig safety and any site and equipment specific safety requirements. The significant potential for hand injuries (including finger amputation) in drilling operations requires proper work practices and well-maintained equipment.

ii. Set up any sample tables and general work areas for the URS field staff to the side of the drill rig (preferably 10 meters away) and not directly behind the rig.

iii. URS engineers, technician, and geologists shall not assist drillers with the drilling equipment or supplies and shall not at any time operate the drill rig controls.

iv. Do not wear loose clothing or jewelry while working near rotating equipment.

b. Safe Use of Augers (Drilling work)

i. When the drill is rotating, stay clear of the drill string and other rotating components of the drill rig. Never reach behind or around a rotating auger for any reason.

ii. Move auger cuttings away from the auger with a long-handled shovel or spade; never use hands.

iii. Never clean an auger attached to the drill rig unless the transmission is in neutral or the engine is off, and the auger has stopped rotating.

c. Other Rotating Equipment (feed augers, chippers, conveyors, etc.)

i. Never place hands, fingers, extremities near hoppers and operational areas of machinery.

ii. When the equipment is rotating, stay clear of the rotating components and only operate equipment with proper machine guarding in place.

iii. Never clean a jammed piece of equipment unless the transmission is in neutral and the power source or the engine is off, and the moving parts of the equipment have stopped rotating. Refer to SMS 23, Lockout and Tagout Safety.

4. Power Saws

   a. Require that circular saws are fitted with blade guards.

   b. Remove damaged, bent or cracked saw blades from service immediately.

   c. Require that table saws be fitted with blade guards and a splitter to prevent the work from squeezing the blade and kicking back on the operator.

   d. Require guards that cover the blade to the depth of the teeth on hand held circular saws. The guard should freely return to the fully closed position when withdrawn from the work surface.

5. Pneumatic Tools and Equipment

   a. Require that pneumatic tools have:

      i. Tool retainers to prevent the tool from being ejected from the barrel during use.

      ii. Safety clip or tie wire to secure connections between tool/hose/compressor if they are of the quick connection (Chicago fittings) type.

   b. Never use compressed air to blow dirt from hands, face or clothing.

   c. Compressed air exhausted through a chip-guarded nozzle shall be reduced to less than 30 psi. Proper respiratory, hand, eye and ear protection must be worn.

   d. Never raise or lower a tool by the air hose.

6. Chain Saws

   a. Inspect the saw prior to each use and periodically during daily use. Refer to the manufacturer's manual for an inspection checklist.

   b. Operate the chain saw with both hands at all times.

c. Never cut above chest height.

d. Require that the idle is correctly adjusted on the chain saw. The chain should not move when the saw is in the idle mode.

e. Start cutting only after a clear escape path has been made.

f. Shut the saw off when carrying through brush or on slippery surfaces. The saw may be carried no more than 50 feet (15 meters) while idling.

g. Require applicable protective gear.

   i. Loggers safety hat.
   ii. Safety glasses.
   iii. Steel-toed boots.
   iv. Protective leggings.
   v. Hearing protection.

h. Inspect saws to ensure that they are fitted with an inertia break and hand guard.

i. Never operate a chain saw when fatigued.

j. Do not allow others in the area when chain saws are operated.

k. Make sure there are no nails, wire or other imbedded material that can cause flying particles.

l. Do not operate a chain saw that is damaged, improperly adjusted, or is not completely and securely assembled. Always keep the teeth sharp and the chain tight. Worn chains should immediately be replaced.

m. Keep all parts of your body away from the saw chain when engine is running.

7. Hand Operated Pressure Equipment

   a. High-pressure water/steam sprayers or cleaners should be used and handled as directed by the manufacturer. Hands should not be cleaned utilizing this equipment.

b. Pressure equipment such as grease guns, paint and garden sprayers shall be directed away from the body and other personnel in the area.

c. Never allow the nozzle of a pressurized tool to come in contact with any body parts while operating. There is potential for injection of a chemical directly into the user's body, resulting in severe injury or death.

8. Physical Hazards – Non-tool

a. Activities such as drum handling, fencing, work near razor-wire, manhole cover removal and demolition also pose hazards to hands

b. The SMS 29 - Personnel Protective Equipment should be utilized to determine what type of PPE will be needed for a job.

c. Plan work to avoid pinch points for hands when moving drums, moving man-hole covers back in to position, and handling other heavy objects.

d. Work handling scrap metal or other sharp edges requires proper hand PPE (Kevlar® or leather gloves).

C. Ergonomics - Hand & Wrist Care

1. Keep your wrist in neutral. Avoid using your wrist in a bent (flexed), extended, or twisted position for long periods of time. Instead try to maintain a neutral (straight) wrist position. Ergonomic tools may be needed for long-term work.

2. Watch your grip. Gripping, grasping, or lifting with the thumb and index finger can put stress on your wrist. When practical, use the whole hand and all the fingers to grasp an object.

3. Minimizing repetition. Even simple, light tasks may eventually cause injury. If possible, avoid repetitive movements or holding an object in the same way for extended periods of time.

4. Reduce speed and force. Reducing the speed with which you do a forceful, repetitive movement gives your wrist time to recover from the effort. Using power tools helps reduce the force.

5. Rest your hands. Periodically give your hands a break by letting them rest briefly. Or you may be able to alternate easy and hard tasks, switch hands, or rotate work activities.

D. Biological Impacts

1. Poisonous Plants

a. Personnel in regions where potential contact with poisonous plants should be aware of the hazard.

i. Avoid contact

ii. Wear appropriate PPE

iii. Thorough hand cleaning after impact prior to further work tasks

2. Further information can be obtained from the SMS 47 - Biological Hazards

E. Cleaning Hands

1. Avoid contamination of hands by proper use of gloves when contact with physical, chemical, or biological hazards is possible.

2. Use soap and water for normal hand cleaning. Do not use solvents for cleaning as they remove essential oils in the skin and may cause dermatitis. Do not use pressure washers for hand cleaning.

3. If the hands contact a corrosive (e.g. nitric acid), wash the area with water for fifteen minutes and then seek medical attention.

4. Use antibiotic ointment and skin protection on minor breaks/scratches of the skin.

5. Resources

A. SMS 16 - Hand Tools and Portable Equipment

B. SMS 29 - Personal Protective Equipment

C. SMS 54 - Office Ergonomics

D. SMS 56 - Drilling Safety Guidelines

URS SAFETY MANAGEMENT STANDARD
INJURY MANAGEMENT

1. Applicability

This standard applies to all U.S. based URS field and office locations.

2. Purpose and Scope

This standard is designed to ensure that employees receive appropriate, immediate, and high-quality health care services that will minimize disability, promote rapid recovery and save lives.

3. Implementation

Office Locations – Implementation of this program is the responsibility of the Office Manager.

Field Activities – Implementation of this program is the responsibility of the Project Manager.

4. Requirements

A. Pre-Injury Management

The following pro-active plans and procedures shall be in place before an injury or illness occurs.

1. Work Site Evaluation

Project and office locations shall evaluate their location for first aid and medical requirements. The following factors should be considered:

Types of accidents that could reasonably occur

Location of local clinics and hospitals

Response time for external emergency services

If corrosive or hazardous materials are in use

Any industry specific requirements

Types of training for employees and first aid responders

What first aid supplies should be available

2. First Aid Services

a. First Aid Responders

At least one person, and preferably two or more, trained in first aid must be available at the worksite if either of these conditions exist:

(1). If life threatening injuries can reasonably be expected, trained personnel must be available within 3 to 4 minutes. This generally means that community emergency medical services cannot be relied on since their response time is usually greater than 3 minutes.

(2). If no life threatening injuries can reasonably be expected, the response time for trained personnel is extended to 15 minutes.

The trained first aid responders should be designated so that the other employees know who they are and how to contact them. The trained responder must have a current first aid certificate and be trained in Bloodborne Pathogens (See SMS 51).

b. First Aid Kits

Each site shall maintain a first aid kit in accordance with SMS 24-9.

c. Emergency Information

Each location shall post a current list of emergency telephone numbers and maps to access local medical emergency providers (SMS 003). Advance contact with ambulance services to ensure they are familiar with location, access routes, and hospital locations is advised in remote or new locations.

d. Eyewash Facilities

If corrosive materials are used, eyewash and body flush facilities must be provided. Where possible, these should provide large quantities of clean water. The water source must be pressure controlled and clearly identified. Portable eyewash stations must contain a minimum of 1 gallon of potable water.

e. Identification of Medical Facilities

Field and office location shall identify a suitable local clinic, preferably specializing in occupational medicine, to treat non-emergency injuries and illnesses. In addition, a local hospital emergency room shall be

identified for treatment of life threatening or after hours injuries. The URS Occupational Health Specialist (OHS) or the workers' compensation insurance carrier pre-injury consultant should be contacted to provide a listing of recommended medical facilities.

The URS H&S Representative should visit the medical facility and meet with the medical provider in order to establish expectations. Clinics should be conveniently located, clean, professionally staffed, offer multiple services and be supportive of early return to work practices.

Field/construction projects shall make appropriate arrangements with local ambulance/emergency service providers prior to the start of work activities to ensure appropriate transportation can be provided in the event of an emergency. These arrangements include establishment of an identifiable project address and emergency access point (i.e. location to meet emergency personnel).

B. Post-Injury Management

1. Transportation

When employees require urgent medical attention as the result of a work-related injury/illness, transportation shall be provided to the doctor's office, clinic, or hospital. Employees should not be permitted to drive unless safe to do so.

2. Emergency Injury/Illness Treatment

In all cases, critical injuries must be immediately referred for professional medical attention. The manner in which the referral is accomplished, and the person responsible for the referral, should be clearly defined in either a project safety plan and/or an office Emergency Action Plan (SMS 003). Critical injuries/illnesses include, but may not be limited to, the following:

Loss of consciousness

Unexplained chest pain

Breathing difficulty

Uncontrolled bleeding

Fractured bones

Suspected internal injuries

Suspected exposure to chemical/biological hazard

Second or third degree thermal or chemical burns (i.e. blistering)

Electrocution

Unexplained change in mental state following an injury (may indicate shock or other internal injuries)

3. Non-Emergency Injury/Illness Treatment

When a work-related incident results in a non-critical injury/illness, the primary objective is to provide appropriate medical services to diagnose and treat the injury/illness. Options available to the employee and project/office management in these situations include the following:

First aid treatment and/or review by a qualified first aid responder

First aid treatment and/or review by a qualified first aid responder followed by a referral to the Occupational Health Specialist (866-326-7321).

Additional support for the employee and managers in these situations can also be obtained from a URS H&S professional.

Attachment 065-1 provides a flow chart to assist employees and managers in determining the most appropriate option for obtaining medical services for non-emergency injuries/illnesses.

Note – Some states allow injured workers to choose their own initial medical provider. Employees are to be cautioned that not all medical providers accept workers' compensation insurance and coverage should be verified prior to treatment if an employee lives in a state that permits him/her to elect to see their personal doctor rather than the company recommended physician.

C. Workers' Compensation Case Management

1. Health and Safety

a. URS Occupational Health Specialist will:

(1). Evaluate and file workers' compensation claims for cases covered by the URS insurance program. Evaluate and provide consultation for injuries occurring in Monopolistic states (Ohio, Washington, West Virginia, North Dakota, and Wyoming).

(2). Provide date of injury support to employees and supervisors, including Monopolistic state claims.

(3). Coordinate regular follow-up of all cases, including Monopolistic state claims, to ensure effective case management.

(4). Offer pre-injury consultation for offices and project sites.

(5). Provide training and communication regarding the workers' compensation process.

b. The Regional and Corporate H&S Managers will assist with the early return to work program by interfacing with the supervisor and employee to evaluate if appropriate and safe temporary transitional work is available.

c. Local H&S Representatives will:

(1). Provide support to the local office or project to ensure that the requirements of this SMS are in place.

(2). Provide training on this SMS to the local office or project site staff.

(3). Ensure proper reporting of incidents in accordance with SMS 049.

(4). Ensure that requirements of this SMS are incorporated into all project H&S plans.

2. Human Resources

a. Local HR Representatives will:

(1). Provide on-site contact for injured employees by maintaining necessary forms and referring employee to OHS to file the workers' compensation claim.

(2). Act as the on-site point of contact for the workers' compensation insurance carrier adjuster.

(3). Forward any external communication (clinic bills, Monopolistic state forms, etc.) to the OHS upon receipt.

b. Regional HR Managers will coordinate any Short Term Disability benefits owed to employees disabled from working over one week because of a work-related injury/illness.

3. Supervisor

The Supervisor (or HR or H&S Representative) will:

a. Sign the Medical Treatment Referral form (065-2) prior to the employee leaving the site for medical treatment (this will not be necessary in an emergency). The employee will also be given the Medical Authorization Form (065-3) to be signed with copy provided to the employee, health care provider and OHS.

b. Provide transitional job assignments, with consultation and approval of the office manager, whenever possible to enable an injured worker to return to work (URS Return to Work Policy 065-4). Transitional employment is defined as temporary modified or light duty work that covers the time from the injury until the release to full duty from the doctor. The return to work hierarchy includes:

(1). Return to own job

(2). Return to own job with accommodations/modifications

(3). Return to another job at URS with or without accommodations/modifications

(4). Placement in alternate jobs through telecommuting or other job assignments determined on a case by case basis.

c. Provide, when requested by the treating physician or insurance carrier, the Description of Employee's Job Duties form (065-5).

d. Maintain regular contact with employees who are temporarily disabled (contact at least weekly by phone or email).

4. Employee

The employees will:

a. Report injuries as soon as possible to their supervisors. Employees are encouraged to contact their supervisor and/or the OHS prior to seeking any medical services for non-emergency injuries and illnesses.

b. Provide the Medical Treatment Referral form to the treating physician. If employees are unable to obtain the form prior to being treated (i.e. onset of symptoms during non-work hours, work in remote locations, etc.) they must notify their supervisor as soon as possible on the next scheduled workday.

c. Provide their supervisor with written return to work and follow up paperwork from the treating physician immediately following each doctor appointment.

5. Documentation Summary

A. The following documents shall be maintained by the H&S Representative:

Posting of medical services providers and emergency phone numbers

List of qualified first aid providers

Documentation of coordination between URS and emergency service providers for field/construction projects.

Completed Injury/Illness/Incident Report Form (SMS 49-1) (copy to OHS)

Description of Employee's Job Duties form (copy to OHS) – 065-5

Medical Treatment Referral form – 065-2

Medical Authorization Letter – 065-3

B. The following documents shall be maintained by the HR Representative and copied to the OHS.

Physician's First Report of Injury and follow up reports

Medical Treatment Referral form

Medical Authorization Letter

Description of Employee's Job Duties form

6. Resources

OSHA 1910.151 Medical Services and First Aid

OSHA Instruction CPL 2-2.53 Guidelines for First Aid Programs

OSHA Safety & Health Topics: Medical and First Aid

Red Cross Health & Safety Services www.redcross.org/services/hss/

SMS 003 Emergency Action Plans

SMS 024 Medical Surveillance

SMS 049 Incident Reporting

SMS 051 Bloodborne Pathogens

URS Medical Services Provider – WorkCare 1-800-455-6155

URS workers' compensation insurance provider AIG – www.aigcs.net

URS Occupational Health Specialist – Jeanette Schrimsher, RN COHN-S

Phone 866-326-7321

Confidential Fax 512-419-6413

Attachments

065-1 Injury Management Procedures (Flow Chart)

065-2 Medical Treatment Referral form

065-3 Medical Authorization Letter

065-4 URS Return to Work Policy

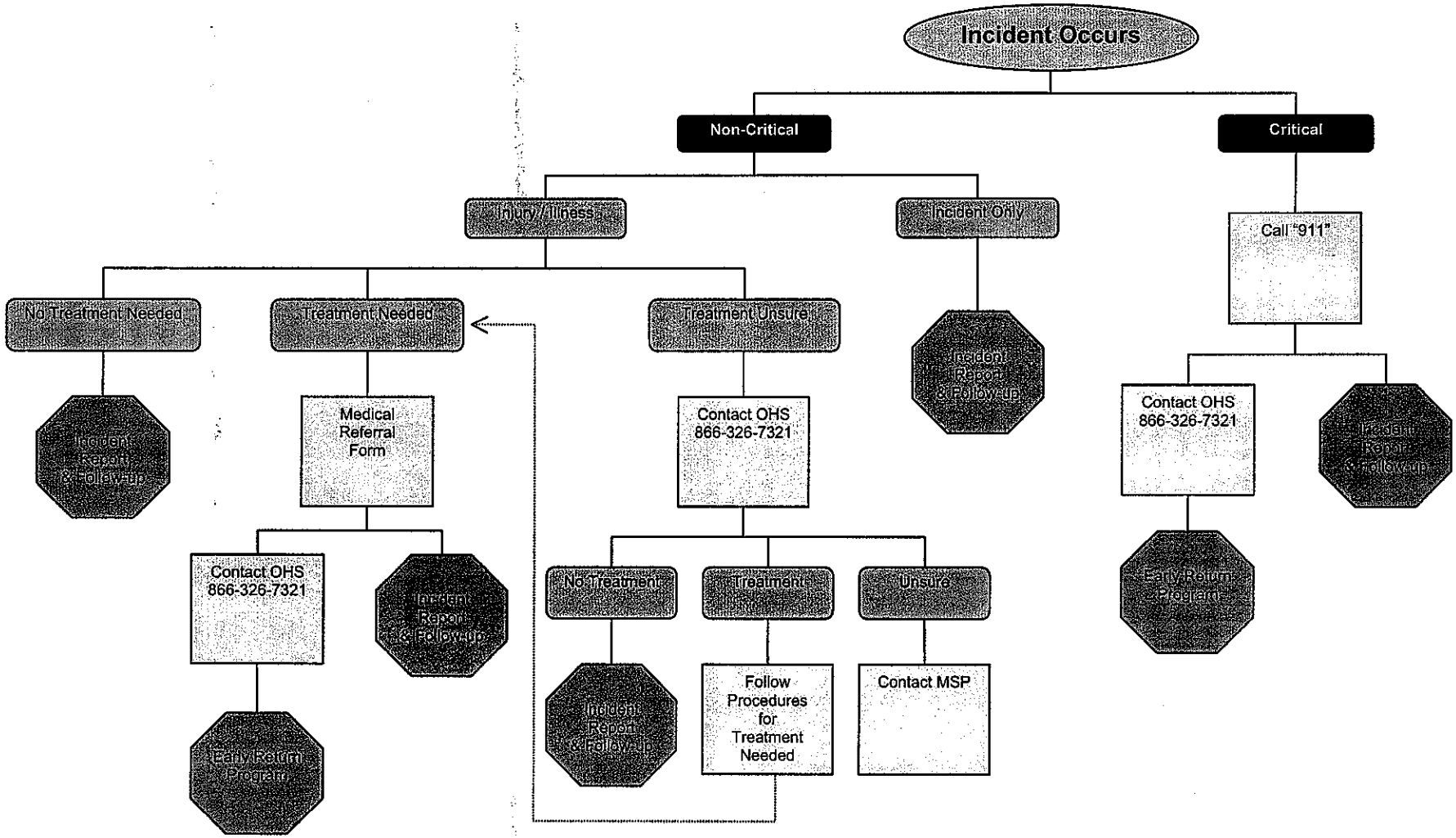
065-5 Description of Employee's Job Duties

URS

Health and Safety Program

INJURY MANAGEMENT PROCEDURES FLOW CHART

Attachment 65-1



URS	Health and Safety Program INJURY MANAGEMENT PROCEDURES FLOW CHART	Attachment 65-1

URS	Health and Safety Program MEDICAL TREATMENT REFERRAL	Attachment 65-2

Date: _____ Site Phone Number: _____

URS Site Contact: _____

Employee Name _____ Social Security # _____

Employee Signature: _____

Brief Job Description _____

_____

Date of Injury _____ Body Part Injured _____

Place of Injury

Post-accident drug and/or alcohol test required? Yes

URS	Health and Safety Program MEDICAL AUTHORIZATION FORM	Attachment 65-3

WORKERS' COMPENSATION
EMPLOYEE AUTHORIZATION LETTER

To be signed with copies provided to employee, URS Occupational Health Specialist and medical provider(s).

To Whom It May Concern:

I, _____ hereby authorize any hospital,
Please Print Name
medical practitioner, clinic, other medical or medically related facility, pharmacy, insurance company to furnish to URS Corporation or its subsidiaries or representatives (orally or in writing), information with respect to any work-related injury or illness including, treatments, consultations, prescriptions, and copies of applicable records that may be requested. I also authorize my employer to disclose information needed to process my workers' compensation claim.

The information provided to URS Corporation, its subsidiaries or representatives is to be used solely for the administration of my workers' compensation claim.

A photo static copy of this authorization is to be considered as valid as the original and is effective for the duration of the claim.

Signature: _____ Date: _____

Note: A true copy of this authorization is available to the employee at any time.

URS	Health and Safety Program RETURN TO WORK POLICY	Attachment 65-4

Our primary goal in safety is the prevention of work related injuries. When an injury does occur, it is the policy of URS to provide our employees with the best possible recovery program. A major component of any successful recovery program is returning the injured employee to the workforce as soon as medically possible. This type of Early Return Strategy has been shown to dramatically reduce the overall recovery time of injured workers creating a benefit for the employee, his/her family, coworkers, and the firm.

As part of this policy, Operations, Human Resources, Health and Safety, and our workers' compensation insurance carrier will work together with our employees and their treating physician to establish a recovery program that minimizes both the number of cases and total days away from work experienced by our employees. URS operations will accommodate transitional work (i.e. light duty or modified work) requirements for employees recovering from work related injuries. The work limits, as defined by the treating physician, will be strictly adhered to. Modified job assignments will be structured to meet the capacities and therapy needs of the injured employee.

URS	Health and Safety Program **DESCRIPTION OF EMPLOYEE'S JOB DUTIES**	Attachment 65-5

Print Name:		
URS Location:	Phone:	
Job Title:	No. Hours Day:	No. Days Week:
General Job Description:		

1. Check the frequency & number of hours a day the activity is performed:

Activity	Frequency		Number of Hours Per Day									
	Continuous	Intermittent	0	1	2	3	4	5	6	7	8	9+
Sitting												
Walking												
Standing												
Bending												
Squatting												
Climbing												
Kneeling												
Twisting												

2. Hand manipulation required? (If yes, complete 2 a, b, c, d) Yes

URS SAFETY MANAGEMENT STANDARD
Manual Material Handling

1. Applicability

This procedure applies to URS operations where personnel perform manual handling of materials. For this procedure, manual material handling (MMH) is defined as the movement of items by lifting, lowering, pushing, pulling, carrying, holding, or restraining.

2. Purpose and Scope

The purpose of this procedure is to prevent common injuries caused by the practice of MMH. Immediate or short-term effects include lacerations, bruises, and muscle fatigue. Long-term effects include chronic pain, typically in the lower back.

3. Implementation

Office/Warehouse Locations– Implementation of this procedure is the responsibility of the Office/Warehouse Manager.

Field Activities– Implementation of this procedure is the responsibility of the Project Manager.

4. Requirements

A. General

1. Prior to lifting, lowering, pushing, pulling, carrying, holding, or restraining an object of any significant size or weight, employees must evaluate the object and the required task to determine if they can handle the object safely.
2. If the employee has any doubt about whether than can safely move the object by themselves, additional manual or mechanical help should be obtained.
3. Healthy employees with no physician imposed restrictions should lift and carry a maximum of 50 pounds (23 kilograms) using proper lifting and carrying techniques. Physical and workplace factors may reduce this recommended weight limit (RWL) significantly and should be considered prior to attempting lifts of this magnitude.
4. An employee's personal "safe" MMH capability is defined as the employee's personal capability to manually lift, carry, push, or pull an object alone. This "safe" limit must consider the employee's past experience and training with MMH, health status, and any other personal or environmental characteristics affecting the employee's ability to perform these tasks. An employee's "safe" MMH capability is typically at or below the calculated RWL.
5. An MMH task that exceeds an employee's personal "safe" MMH capability or RWL should be brought to the attention of the Project Manager.
6. If, due to a medical or health condition, the employee's physician or the employee has set a personal "safe" MMH capability, then appropriate medical documentation must be provided to the Project Manager to define these limits.
7. A recommended RWL can be calculated using the factors described in Attachment 69-1. The weight limit derived from these calculations is considered to be a load that over 99% of men and over 75% of women can safely handle without application of engineering or administrative controls. **Implementation of the calculations in Attachment 69-1 should only be attempted with the assistance of a safety professional knowledgeable in the application of**

these factors. The calculations are intended to determine RWLs for repetitive lifting scenarios rather than occasional lifts.

B. Pre-Planning

1. If a heavy object is to be moved to another location, the safest transport route should be determined prior to the activity.
2. The area around the object and the route over which it will be transported should be checked for slip, trip, and fall hazards. Hazards should be removed prior to initiation of the task.
3. The object to be moved should be inspected for grasping or handling hazards, including slivers, sharp edges, grease, water, etc. Eliminate or abate any identified hazards where possible. Safe grasping or handling points on the object should be determined.
4. The distance to be traveled and the length of time which a grip on the object must be maintained should be considered before moving objects.

C. Lifting/Lowering Guidelines

1. Reduce or eliminate manual lifting and lowering tasks where possible. Determine if there are ways to abate the safety and ergonomic hazards associated with manual lifting.
2. The recommended technique for manual lifting/lowering involves five maneuvers:
   a. Get a firm footing. Keep your feet apart for a stable base. Put one foot slightly in front of the other.
   b. Bend your knees. Do not bend at the waist. When grasping the object, a firm grip should be obtained before lifting/lowering.
   c. Lift/lower with your legs. Lift/lower the load slowly and in a straight line, avoiding sudden movements.
   d. Keep the load close to the body. Generally, the closer the load is to the body, the less force it exerts on your back.
   e. Keep your back straight. Do not add the weight of your body to the load. Avoid twisting.
3. When a turn or change of direction is necessary, the object should be lifted or lowered into a carrying position, then the whole body should be turned with the feet, avoiding any trunk twisting motion.
4. Objects to be lifted to shoulder height should first be lifted to waist height, then rested on a level surface so the grasping position can be changed prior to lifting to a higher level.
5. Employees should never lift a load above their head.

D. Carrying/Holding Guidelines

1. Manual carrying is an inefficient way of transporting materials in the work place. Where possible, reduce or eliminate manual carrying tasks.
2. Employees should never carry a load above their head.

3. Carry an object close to the body using both hands. One-handed carries are awkward and tend to unbalance the employee.
4. Do not carry objects that are so large they will obstruct visibility.
5. Grips on an object should not be changed while carrying or holding an object. Rest the object on a secure surface prior to changing grip.
6. Avoid two person carries where possible. If an object is of a size, shape, or mass that it requires two people to carry, use two people of similar size and physique. Perform lifting of the item in unison.
7. Avoid carrying objects on stairs, particularly where the line of sight may be obstructed or the object can interfere with leg movement.

E. Pushing/Pulling Guidelines

1. Check the condition of the floor, ground, or other surface prior to pushing or pulling an object across it.
2. Be aware of the "break out" force of the object - the force at which a push or pull overcomes the frictional force between the surface and object. Adjust posture to avoid losing balance when this point is reached.
3. Get assistance when moving or guiding a large load.
4. Where possible, always push rather than pull a load.

F. Workplace Design

1. Store heavy or bulky materials at heights between the knee and shoulder to avoid the need to stretch or bend.
2. Pack or arrange items to be lifted to avoid shifting of weight in the package.
3. Design work areas to avoid the need to lift, carry, push, or pull heavy or bulky materials for extended distances.
4. Design workplaces with the following in mind.
   a. Lifts from the floor should be avoided.
   b. The torso should never twist while handling loads.
   c. Asymmetrical or unbalanced one-handed lifts should be avoided.
   d. Loads should not be lifted with sudden movements.
   e. Loads should not be lifted over obstacles.
   f. Loads should not be lifted at extended reaches.
   g. Uncomfortable postures should not be necessary throughout the work cycle.
   h. Environmental factors (e.g., task lighting, dry work surfaces, heat stress) should be considered.

G. Training

1. Require that personnel who may have MMH as part of their duties receive training that includes the following topics:

a. Showing personnel how to avoid unnecessary physical stress and strain during MMH operations.

b. Teaching personnel to become aware of what they can comfortably handle without undue strain.

c. Instructing personnel on the proper use of equipment.

d. Teaching personnel to recognize potential hazards and how to prevent or correct them.

2. This training must be completed prior to an employee being assigned to a task that involves MMH activities.

5. Documentation Summary

Training rosters or other proof of completion of MMH training will be filed in the Project or Office Health and Safety File.

6. Resources

A. Recommended Weight Limit Calculations (RWL) – Attachment 69-1

B. Work Practices Guide for Manual Lifting, NIOSH
http://www.cdc.gov/niosh

C. Canadian Centre for Occupational Health and Safety
http://www.ccosha.ca/oshaanswers/ergonomics/mmh/

D. Oregon OSHA "Ergonomics of Manual Materials Handling"
http://www.cbs.state.or.us/external/osha/pdf/workshops/206w.pdf

E. North Carolina Department of Labor "A Guide to Manual Materials Handling and Back Safety http://www.nclabor.com/osha/etta/indguide/ig26.pdf

F. European Agency for Safety and Health at Work
http://uk.osha.eu.int/good_practice/msd.stm

This lifting equation, developed by the National Institute for Occupational Safety and Health (NIOSH), takes into account the weight of an object plus several other variables in lifting tasks that contribute to the risk of injury. For example, if the situation requires frequent lifts or lifting loads far away from the body, there is an increased risk of injury. Under these conditions, the weight limit would be reduced from a baseline weight or "load constant" (LC) to a recommended weight limit (RWL). A "load constant" (LC) of 23 kg (about 51 pounds) has been established by NIOSH as a load that, under ideal conditions, is safe for 75% of females and 90% of males.

To calculate the RWL, you must first measure or assess several variables related to the lifting task. The six variables that are considered in determining the RWL are:

The horizontal distance (H) the load is lifted (distance of hands from midpoint between ankles),

The starting height of the hands from the ground (V),

The vertical distance of lifting (D),

The time between lifts or frequency of lifting (F),

The angle of the load in relation to the body (e.g., straight in front of you or off to the side, A), and

The quality of the grasp or handhold based on the type of handles available (hand-to-load coupling, C).

Each of these variables is then assigned a numerical value (multiplier factor) from look-up charts. The equation includes six multiplier factors to calculate the RWL:

$$RWL = LC \times HM \times VM \times DM \times FM \times AM \times CM$$

Where LC is the load constant (23 kg) and other factors in the equation are:

HM, the "Horizontal Multiplier" factor,

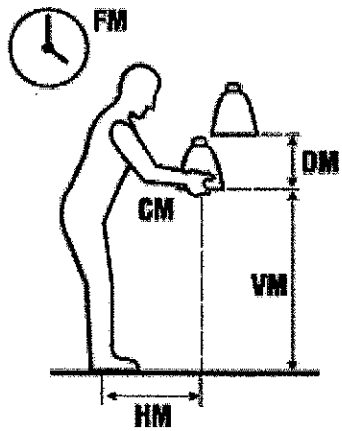
VM, the "Vertical Multiplier" factor,

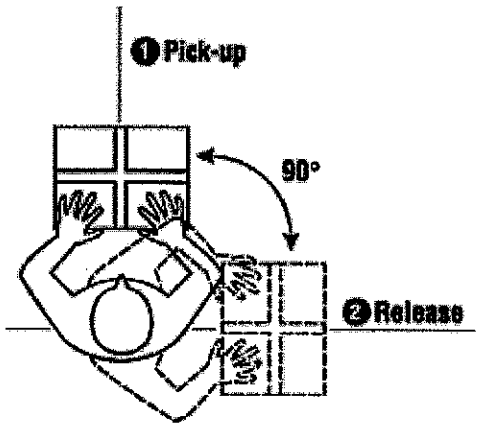
DM, the "Distance Multiplier" factor,

FM, the "Frequency Multiplier" factor,

AM, the "Asymmetric Multiplier" factor, and

CM, the "Coupling Multiplier" factor.





Horizontal Multiplier is the distance the object is from the body. Measure (in centimeters) the distance from in between the person's ankles to their hands when holding the object. Write down this number. Next, look up the number on the accompanying chart and find the matching "multiplier factor". Use this factor in the lifting equation.

Vertical Multiplier is measured as the starting point of the lift and is the distance in centimeters of the hands up from the ground. Measure this distance and use the number to determine which value to use on the chart.

Distance Multiplier is the number of centimeters the load travels up (or down) from the starting position. Measure this distance and use the number to determine which value to use on the chart.

Frequency Multiplier is how often the lift is repeated within a certain time period. You need to determine if the lift is done while standing or stooping, for more or less than one hour (in total time for the shift), and how much time there is for rest between lifts.

Asymmetric Multiplier measures if the body must twist or turn during the lift. This measurement is done in degrees (with 360 being one complete circle).

Coupling Multiplier determines the "coupling" or type of grasp the person has on the container. It rates the type of handles as good (handles), fair (make-shift cut outs in cardboard boxes) or poor. You also need to know if the lift is done in a standing or stooping position.

When these multipliers are placed into the equation, determine the RWL. If the weight of the object to be lifted exceeds the RWL, the task is considered to be dangerous. Assess the relevant factors which contribute most to the risk (the lower the factor, the more it contributes to the risk) and redesign the handling task.

The lifting equation only applies in certain situations. It does not apply in situations where a person is lifting (or lowering):

With one hand,

For over 8 hours,

While seated or kneeling,

In a restricted work space,

Objects that are unstable (such as buckets or containers of liquids),

While pushing or pulling,

With wheelbarrows or shovels,

With high speed motion (faster than about 30 inches/second),

Extremely hot or cold objects or in extreme temperatures, or

With poor foot/floor coupling (high risk of a slip or fall).

This equation applies to most workers for:

Two-handed lifting,

Comfortable lifting postures, and

Comfortable environments and non-slip floorings.

FACTORS USED IN RWL CALCULATIONS

Horizontal Multiplier (HM): Horizontal distance (H, in cm) from the midpoint between the ankles to the hands while holding the object.

H = Horizontal Distance (cm)	HM Factor
25 or less	1.00
30	0.83
40	0.63
50	0.50
60	0.42

Vertical Multiplier (VM): The vertical distance (V, in cm) of the hands from the ground at the start of the lift.

V = Starting Height (cm)	VM Factor
0	0.78
30	0.87
50	0.93
70	0.99
100	0.93
150	0.78
175	0.70
>175	0.00

Distance Multiplier (DM): The vertical distance (D, in cm) that the load travels.

D = Lifting Distance (cm)	DM Factor
25 or less	1.00
40	0.97
55	0.90
100	0.87
145	0.85
175	0.85
>175	0.00

Asymmetric Multiplier (AM): The twisting angle (A) of the body while lifting, measured in degrees.

A = Angle (degrees)	AM Factor
90°	0.71
60°	0.81
45°	0.86
30°	0.90
0°	1.00

Frequency Multiplier (FM): The frequency (F) of lifts and the duration of lifting (in minutes or seconds) over a work shift.

F = Time Between Lifts	FM Factor			
	Lifting While Standing		Lifting While Stooping	
	One Hour or Less	Over One Hour	One Hour or Less	Over One Hour
5 min	1.00	0.85	1.00	0.85
1 min	0.94	0.75	0.94	0.75
30 sec	0.91	0.65	0.91	0.65
15 sec	0.84	0.45	0.84	0.45
10 sec	0.75	0.27	0.75	0.27
6 sec	0.45	0.13	0.45	-
5 sec	0.37	-	0.37	-

Coupling Multiplier (CM): The quality of grasp (or coupling, C) classified as good, fair or poor and depends on the body position (either standing or stooping).

C = Grasp	CM Factor	
	Standing	Stooping
Good (handles)	1.00	1.00
Fair	1.00	0.95
Poor	0.90	0.90